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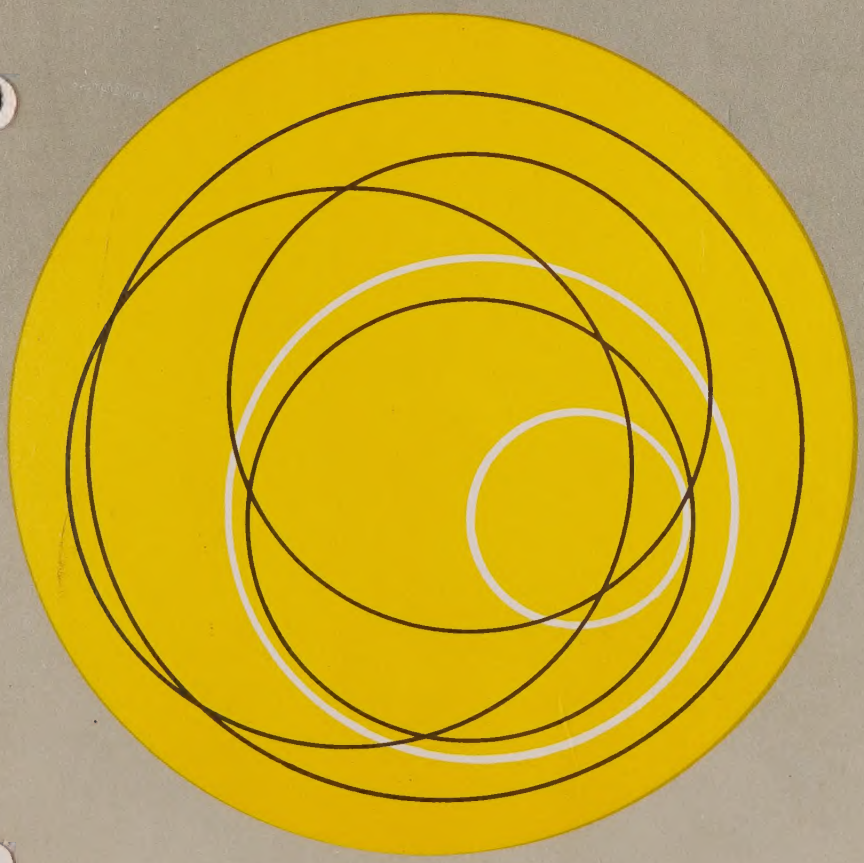
INSTRUCTION MANUAL

micro-derm®
Model MD-3



UPA

UNIT PROCESS ASSEMBLIES, INC.

QUALITY ASSURANCE
STANDARDS, CALIBRATION, AND
MAINTENANCE LAB.

micro-derm®

Model MD-3

Unit Process Assemblies, Inc. are pioneers in electronic instruments for the measurement of coating thickness.

The **Micro-Derm** measures almost any type of coating non-destructively, from a fraction of a micro-inch up to several thousandths. A simple setting of the **Micro-Derm,** and the coating thickness can be read directly and accurately.

Especially suited for precious metal coatings, the **Micro-Derm** operates on the Beta-ray backscatter principle and is equally effective with other metallic and non-metallic coatings on objects of almost any size or shape.

Micro-Derm is a registered trade mark of Unit Process Assemblies, Inc., for its non-destructive electronic thickness tester, based on Beta-ray Backscatter principles.

Dermitron and Micro-Derm

Unit Process Assemblies, Inc.

53-15 37th AVENUE WOODSIDE, NEW YORK 11377 AREA CODE 212 TEL. 899-9090

INTRODUCTION

This instruction manual contains installation, operation, and routine maintenance instructions for the Model MD-3 MICRO-DERM and presents step-by-step operating procedures for its most effective use. Various accessories are available for use with the MICRO-DERM, depending on the particular application. The accessories are briefly described in the Addenda of this manual. For detailed operating and maintenance information covering the accessories, refer to the appropriate accessory manuals. Since this manual provides the key to all MICRO-DERM systems, it is strongly recommended that the user study its contents before operating the MICRO-DERM.

The information included in this manual is sufficient for most applications. If other questions arise, please write or call Unit Process Assemblies, Inc. We will be pleased to provide additional instruction at our offices to any technician assigned to MICRO-DERM operation. There is no charge for this course and the instruction can be given in about half a day. Should it be possible for one of your people to spend time with us, we are sure that such instruction would increase the versatility of your MICRO-DERM.

CAUTION

MICRO-DERM probes contain radioactive sources and must be handled with care. Refer to the applicable probe manual for details of regulations covering these radioisotopes.

BASIC SET-UP PROCEDURE

1. Select the appropriate Radioisotope Source and calibration for the combination and thickness range to be measured. See chart on pages 20 through 23. Note that the proper MODE and RANGE switch settings are listed for each calibration.

2. If using a Model PS-3 through PS-10 Probe System or one that uses a Model HH-3 Probe, determine which aperture or specimen mask to use (see Probe System Manual) for the particular shape of work.

3. If settings for RATE switch and TIMER control (measuring time) have been previously determined for the above conditions and are known, proceed to step 4. If proper settings are not known, follow the procedures on pages 27 and 28.

4. Standardize the MICRO-DERM. (More details of the standardization procedure are given on pages 16 and 17.) Note that this procedure does not apply to determining solder composition - see page A-4.

   a) Set the RANGE switch to LINEAR. Set the TIMER control to 2 minutes so that you get better repeatability for standardization.

   b) Take a reading on the bare standard and, when the time period is over, hold the RESET button in the depressed position and use the ZERO control to set the neon THICKNESS display to "00.0".

   c) If not already known, find the "Calibration Number" by first multiplying the thickness of the standard by the multiplier (pages 20-23) and then finding the calibration number on the MD-3 calibration graph (page 25).

   d) Take a reading on the coated thickness standard and, when the time period is over, hold in the RESET button and use the CAL control to set the neon THICKNESS display to the calibration number. Continue to depress the RESET button, switch to the proper RANGE position, and use the CHECKPOINT control to set the neon digits in the THICKNESS display to the actual thickness of the standard.

5. After standardizing, check your bare (uncoated) production piece to ensure that it is the same as the bare standard. (See page 31.)

6. Set the TIMER control to the desired measuring time and proceed to take measurements.

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Section 1

GENERAL DESCRIPTION

1-1. PURPOSE OF EQUIPMENT

The Model MD-3 MICRO-DERM (figure 1-1) is an electronic non-destructive coating thickness gauge that provides direct digital readout of coating thickness in millionths-inch, mils, or microns. Incorporating solid state IC construction, this precision instrument measures the thickness of all types of coatings on almost any base material. It is fast and accurate and, in combination with specially-designed probes, is ideal for measuring plating and coatings on connectors, flat packs, printed circuit board surfaces and through-holes, terminals, transistor headers and leads, diodes, watchbands, watch cases, jewelry, etc.

1-2. BASIC OPERATING PRINCIPLES (See figure 1-2.)

The MD-3 uses Beta-rays, reflected from the surface of the object being measured, to determine coating thickness. These rays are emitted from a radioactive source in the probe. Since the amount of radioactive material is very small and properly sealed, it is perfectly safe for use.

The reflected Beta-rays bounce into the window of a Geiger Tube in the probe which converts the rays into electrical impulses and passes them to the basic MICRO-DERM unit. The MD-3 then counts the impulses received during a preset time interval and provides a direct digital readout of coating thickness.

Figure 1-1. Model MD-3 MICRO-DERM

Two basic principles underlie the operation of the MICRO-DERM: (1) The number of Beta-rays reflected from different materials varies as a function of their atomic number, with higher Atomic-numbered materials reflecting more rays than the lower-numbered materials, and (2) as the thickness of the coating material increases, it reflects more rays while reducing the rays reflected by the base material. The MD-3, which is basically a comparator, uses these principles to measure unknown coating thicknesses. First, a sample of the uncoated base material is placed on the probe. After a preset measurement time interval, the THICKNESS display on the MD-3 is adjusted to read zero. A Thickness Standard (coated sample of known thickness) is then placed on the probe and a measurement is made for the same time interval. The instrument is then adjusted to read the known coating thickness. After the MD-3 has thus been "standardized" on both the base sample and Thickness Standard, it is ready to make direct thickness measurements on like combinations of coating and base material.

Depending on the particular combination of materials, coating thickness range, shape of material to be measured, and so forth, different isotopes, probe systems and other accessories to the MD-3 may be obtained to perform the required thickness measurements.

For additional notes on principles of operation, refer to page A-8 of Appendix.

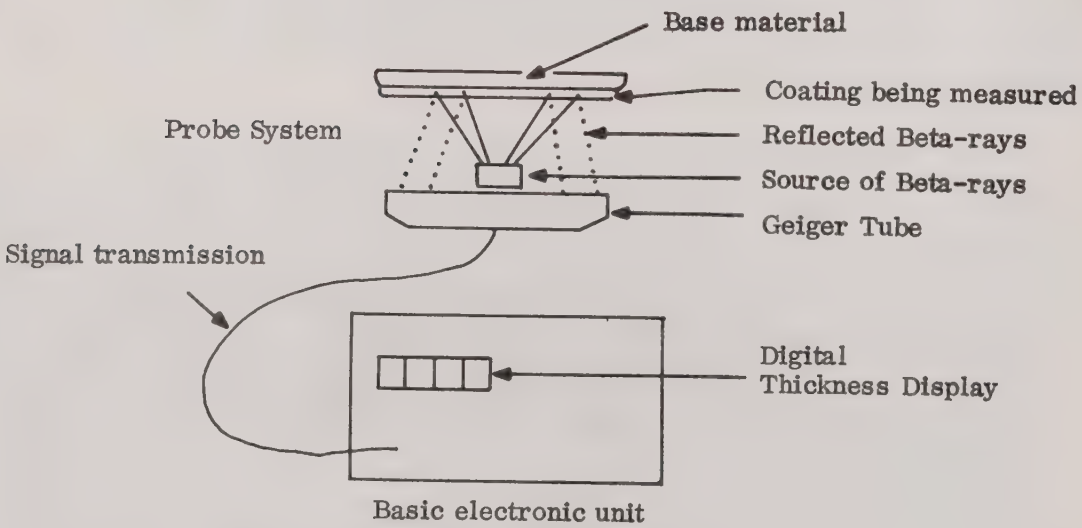

Figure 1-2. Basic MICRO-DERM Operation

Section 3

OPERATING INSTRUCTIONS

3-1. OPERATING CONTROLS AND INDICATORS

The controls and indicators on the front and rear panels of the MD-3 are described in Tables 3-1 and 3-2, and shown on figures 3-1 and 3-2. The operator of the MD-3 should become thoroughly familiar with the function and use of these controls and indicators before operating the unit.

Table 3-1

OPERATING CONTROLS AND INDICATORS (See figure 3-1)

Item	Function
(1) POWER ON lamp	Lights when unit is turned on.
(2) POWER switch	Applies power to unit. (This switch may be left on continuously, if desired, since the instrument is designed for continuous 24-hour operation.)
(3) TIMER control	Sets measurement time interval. Provides choice of 1/8, 1/4, 1/2, 1 or 2 minutes.
(4) RATE switch	Used to extend operating range of ZERO and CHECKPOINT controls. (See page 27.) In TEST position, known signal is applied to unit and THICKNESS reading should fall between 900 and 1100.
(5) RANGE switch	In positions 1 through 4, selects position of decimal point in THICKNESS readout. In LINEAR position, selects linear calibration for certain specified applications.
NOTE After calibration, when measuring thickness, the RANGE switch must be set to position 1, 2, 3, or 4. Recommended RANGE switch positions for different applications are given on pages 20 through 23.	
(6) LAMP connector	Accepts cable from probe system lamps, if lamps are used.
NOTE Lamp voltage is not applied during measurement intervals.	

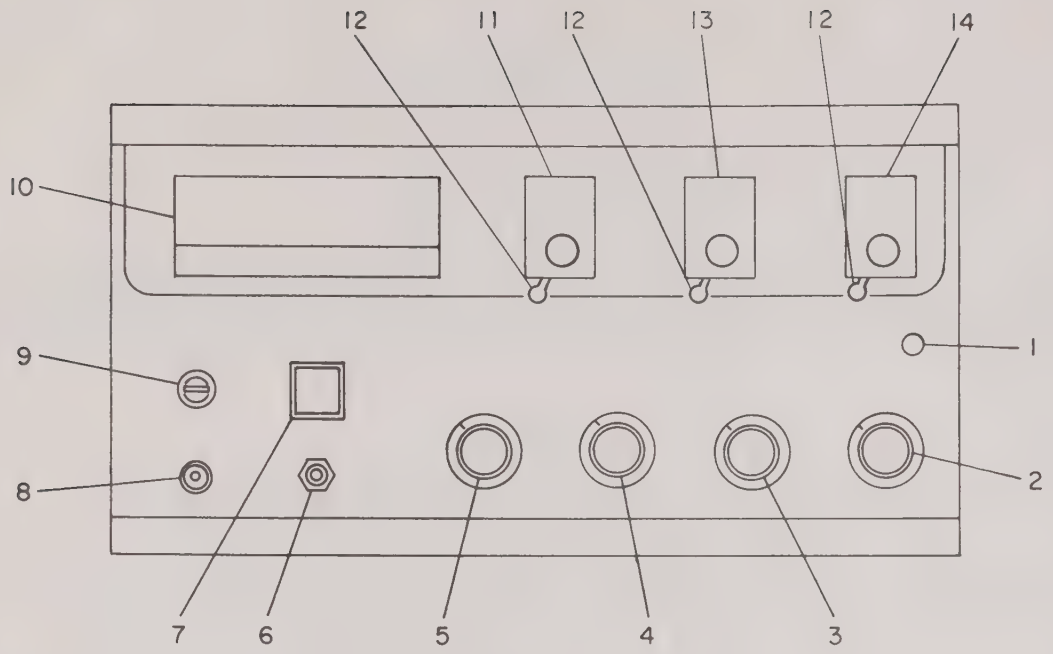

Figure 3-1. MICRO-DERM, Front View

Table 3-1

OPERATING CONTROLS AND INDICATORS (contd)

Item	Function
(7) RESET switch	When pushed in and released, erases previous measurement and simultaneously starts new measurement. TIMER ON button lights while the new measurement is being made. Holding the RESET switch depressed will not erase the previous reading and permits the controls to be adjusted. The switch should not be released, even momentarily, while adjusting for a new reading.
(8) PROBE connector	Accepts cable from selected probe system.
(9) MODE switch	Sets polarity of digital reading. NORMAL setting is used when coating has higher atomic number than base. REVERSE setting is used when coating has lower number than base. (See pages 20-23.)

Table 3-1

OPERATING CONTROLS AND INDICATORS (contd)

Item	Function
(10) THICKNESS display	Provides digital reading of coating thickness. The numbers in this window light up only after the measurement interval is over. Each reading remains on until another reading is taken. (Reading may be released by holding in RESET button so that controls may be adjusted.) The following symbols may appear at left side of display: "+" indicates that reading is above zero and is valid if it is in range listed on pages 20 through 23 for the particular application. "–" Indicates a below-zero reading which should not be used. To switch to a "+" reading, set MODE switch to its opposite position. "R" (Weston meter), or "$\underset{L}{O}$" (Electro-Numerics meter) If either of these appear when the THICKNESS digits first flash on, it indicates that reading is over-range and cannot be used. The THICKNESS display has a range from 000 to 1999. Any reading above 1999 is invalid and will cause the over-range indication to flash on. (In some Weston units, although the "R" may only flash momentarily as the digits first flash on, it will flash continuously if the RESET switch is depressed.)
(11) ZERO control	Used to zero the THICKNESS reading after taking a reading on bare sample (standard) of base material. Its effect on reading depends on setting of MODE switch. With MODE switch in NORMAL position, clockwise movement of control increases the reading; in REVERSE position, reading is decreased. Only when standardizing the MICRO-DERM by averaging readings (page 30), is it necessary to average the numbers which appear in the small window above the knob. This is the main application of these "digi-dial" readings.
(12) Lock lever	Used to lock associated ZERO, CAL, or CHECKPOINT control, preventing accidental movement. When lever is pushed to the left, control may be rotated freely. When set to the right, it locks the control.

Table 3-1

OPERATING CONTROLS AND INDICATORS (contd)

Item	Function
NOTE Some units are equipped with a slightly different control in which locks are on the right side. On these, the lever is pushed down to lock control and pushed up to unlock control.	
(13) CAL control	Used to adjust THICKNESS display to read a predetermined Calibration Number after taking a reading on Thickness Standard (see page 17). Clockwise rotation of this control always increases reading on display. Small numbers in window are used as described for ZERO control (item 11).
(14) CHECKPOINT control	Used to set THICKNESS display to thickness of standard value after setting CAL control (see page 17). Clockwise rotation of this control always increases reading on display. Small numbers in window are used as described for ZERO control (item 11).

Table 3-2

REAR PANEL SWITCHES AND DEVICES
(See figure 3-2.)

Item	Function
(1) Fuse	1/2 Amp fuse (BUSS AGC 1/2) The same fuse is used for 115- or 230-volt operation. To gain access to a blown fuse, first disconnect linecord from ac line, then unscrew fuseholder cap.
(2) LINE VOLT SELECTOR switch	Conditions MD-3 for operation from either 115 or 230 volts ac.
(3) BCD OUTPUT connector	Supplied only on special order, this connector permits a digital printer to be connected to the digital readout. Contact UPA Sales Dept. for more details.

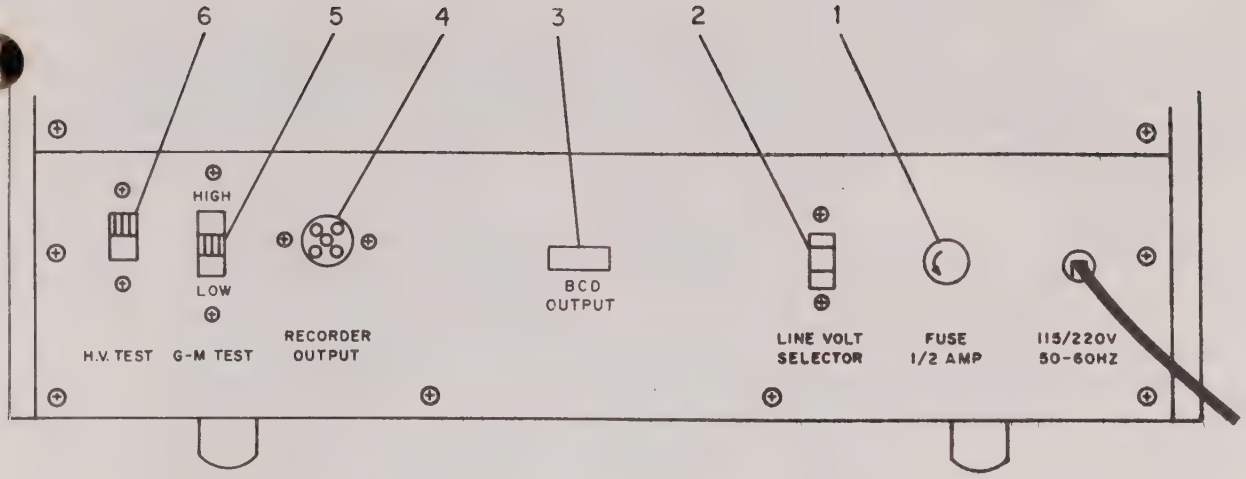

Figure 3-2. MICRO-DERM, Rear View

Table 3-2

REAR PANEL SWITCHES AND DEVICES (contd)

Item	Function
(4) RECORDER OUTPUT connector	Provides means for recording thickness reading on external chart recorder. Also permits certain factory tests to be run automatically.
NOTE For more information concerning recorder output operation, contact UPA Sales Department.	
(5) G-M TEST switch	Used to apply lower or higher voltage to Geiger tube for test purposes.
(6) H. V. TEST switch	When held in lower position (with RESET switch depressed) this spring-loaded red switch permits check of high voltage (approx. 920 volts) generated by MD-3 to operate Geiger-Muller tube in probe system. Used in conjunction with THICKNESS display whose reading indicates the high voltage directly, as described on page 33. (The decimal point is erased automatically when the H. V. TEST switch is in the lower position.)

3-2. OPERATING PROCEDURE

Table 3-3 is a summary of the MD-3 operating procedures. For more information on a particular procedure, refer to the pages shown in the "reference" column of the table. After becoming fully experienced with the operation of the MICRO-DERM, you may find it more convenient to refer to the "Basic Set-Up Procedure" sheet (page 3) rather than the detailed procedures given below.

NOTES

1. The procedure given in Table 3-3 does not apply to measurement of composition of tin-lead. Refer to Appendix D (page A-4) for details.
2. Since different Probe Systems may be used with the MICRO-DERM, refer to the associated Probe System manual for details of isotope installation, probe positioning, etc.

Table 3-3

MICRO-DERM OPERATING PROCEDURE

Step	Procedure	Reference
1	Plug MD-3 into proper (115- or 230-volt) ac source and set POWER switch to ON. The POWER ON lamp should light. Allow the unit to warm up for about 10 minutes so that it stabilizes.	page 9
2	Refer to your Set-up Sheet for the isotope source and standards recommended for your application. If necessary, select most appropriate source and standards.	pages 20 through 23
3	Determine which aperture plate or specimen mask opening to use for the particular size and shape of your parts. Set up the selected Probe System with the proper isotope and aperture plate or specimen mask. Connect the Probe System to the PROBE connector (and LAMP connector, if appropriate) on the MD-3. NOTE If lamp cable is used, be sure jack on cable is fully inserted in LAMP connector.	Probe System Manual
4	Refer to your Set-up Sheet (if available) for RATE switch setting for your application. The TIMER control can be set to 1/2 or 1/4 minute for most applications. If necessary, determine RATE switch settings.	pages 27 and 28
5	Standardize your MD-3 as follows: a. Set RATE switch to its setting determined in step 4 and set the TIMER control to four times the setting selected in step 4 (or 2 minutes).	

Table 3-3

MICRO-DERM OPERATING PROCEDURE (contd)

Step	Procedure	Reference
5 (cont)	b. Set MODE switch to NORMAL or REVERSE, depending on coating-base combination.	page 12 pages 20-23
	c. Set RANGE switch to LINEAR.	
	d. Install source in probe.	Probe System Manual
	e. Place bare standard in proper position for measurement with Probe System.	Probe System Manual
	f. Press RESET button all the way in, then release it.	
	g. When THICKNESS display lights up, hold RESET button in depressed position and adjust ZERO control so that reading on neon THICKNESS display becomes 00.0. Now release RESET button.	
	h. Replace bare standard with Thickness Standard.	
	i. Press RESET button all the way in (even if TIMER ON light is already on), then release it and wait for the time period to elapse.	
	j. After the THICKNESS display lights up, press and continue to hold RESET button in, adjusting CAL control until the reading on the neon display corresponds to the "Calibration Number" of the standard. Do not release RESET button.	
	NOTE The "Calibration Number" is obtained by multiplying the standard's thickness by a factor and then consulting a chart.	page 24
	k. With RESET button still depressed, set RANGE switch to its proper direct reading position and adjust CHECK-POINT control so that reading on neon display corresponds to actual thickness value of the standard. Now release the RESET button.	

Table 3-3

MICRO-DERM OPERATING PROCEDURE (contd)

Step	Procedure	Reference
5 (cont)	NOTE The RANGE switch may be set to any one of the four direct-reading positions. The only difference between these numbered settings is the position of the decimal point in the THICKNESS display. As long as the "Calibration Number" has been properly set, the decimal point may be set to whichever position gives you the desired thickness reading. However, once selected, you may not change the RANGE switch position without making a new setup.	
6	You may now measure unknown coating thickness of pieces with the same coating-base combinations. First, reset TIMER control to its normal setting (step 4). Now replace Thickness Standard with your part to be measured, depress and release RESET button, wait until THICKNESS display lights up, then read actual thickness value from the display. NOTES A. If measurements are taken over a period of several hours, it is recommended that the standardization of the MICRO-DERM be checked to assure that nothing has influenced the calibration. The average calibration requires checking at least once or twice a day. To check the standardization, use a longer time setting than you use for measuring. First, check the bare standard and then the coated standard. Remember that small (about ±3-5% of the coated standard) variations are <u>normal</u> for beta-backscatter measurements and do <u>not</u> represent a shift in standardization. If it is desired to adjust the controls, only the ZERO and CAL controls should be adjusted unless the complete standardization procedure (step 5) is repeated. The CAL control is used to adjust the actual direct reading thickness value on the neon display. The CHECKPOINT control serves only to set the internal circuits so that readings are "translated" to their proper direct-reading thickness equivalents and therefore requires no readjustment.	Page 30

Table 3-3

MICRO-DERM OPERATING PROCEDURE (contd)

Step	Procedure	Reference
6 (cont)	B. To reduce the normal variation in successive readings when greater accuracy is required, increase your measuring time or use the optional averaging procedure. Also be sure that the largest size aperture is being used, consistent with the geometry of the part being measured.	pages 29 through 31
	C. If your bare (uncoated) production piece produces a different zero reading than the bare standard supplied, apply correction to readings.	page 31

MICRO-DERM MD-3 CALIBRATION RANGES

British Units { 1.0 microinch = .000001 inch
1.0 mil = .001 inch

For Surface Measurements with "PS" or "HH" Series Probe Systems

COMBINATION	Mode	Thickness Limits	Units of Calibration	Range Switch	Isotope Used	Zero-Set Material	Approximate Checkpoint	Multiplier for Set-Up
GOLD on Nickel (Au/Ni) (also for: GOLD on Brass or Copper; see correction factor on page 31.) (see page A-2)	N	0-45*	microinches	4	C	Nickel	30	0.535
		0-70	microinches	4	Pm		60	0.355
		0-340	microinches	4	Tl		220 or 100	.0869
		0-500	microinches	4	Ra		320	.0802
		0-1200	microinches	4	Sr		700	.0824
GOLD on Kovar (Au/Kvr) (also for: GOLD on Invar; see correction factor on page 31.)	N	0-45*	microinches	4	C	Kovar	30	0.535
		0-70	microinches	4	Pm		60	0.355
		0-340	microinches	4	Tl		220 or 100	.0869
		0-500	microinches	4	Ra		320	.0802
		0-1200	microinches	4	Sr		700	.0824
GOLD on Steel (Au/Fe)	N	0-45*	microinches	4	C	Steel	30	0.535
		0-70	microinches	4	Pm		60	0.355
		0-340	microinches	4	Tl		220 or 100	.0869
		0-500	microinches	4	Ra		320	.0802
		0-1200	microinches	4	Sr		700	.0824
GOLD on Silver (Au/Ag) (see page A-1)	N	0-300	microinches	4	Tl	Silver	230	.0538
SILVER on Copper (Ag/Cu) (also for: SILVER on Brass or Nickel; see correction factor on page 31.)	N	0-90*	microinches	4	C	Copper	60	0.260
		0-120	microinches	4	Pm		90	0.185
		0-700	microinches	4	Tl		470	.0383
		0-1100	microinches	4	Ra		750	.0388
SILVER on Kovar (Ag/Kvr) (also for: SILVER on Invar; see correction factor on page 31.)	N	0-120	microinches	4	Pm	Kovar	90	0.185
		0-700	microinches	4	Tl		470	.0383
		0-1100	microinches	4	Ra		750	.0388
SILVER on Steel (Ag/Fe)	N	0-120	microinches	4	Pm	Steel	90	0.185
		0-700	microinches	4	Tl		470	.0383
		0-1100	microinches	4	Ra		750	.0388
SILVER on Gold (Ag/Au) (See page A-3)	R	0-100	microinches	4	C	Gold	75	0.241
SOLDER on Copper (Sn-Pb/Cu) (See page A-4)	N	0-140	microinches	4	Pm	Copper	85	0.446
		0-950	microinches	4	Tl		550	.0493
		0-1.2	mils	2	Ra		1.0	35.6
COMPOSITION of Electro-plated Solder (%SnPb) (See page A-4)	N	0-80%	Indicator gives lead percentages	Linear	Pm	Tin	60/40 (40% lead)	Not used
RHODIUM on Nickel or Copper (Rh/Ni)	N	0-60*	microinches	4	C	Copper	40	0.268
		0-110	microinches	4	Pm		80	0.225
		0-1.0	mils	2	Tl		0.6	50.06
RHODIUM on Gold (Rh/Au) (See page A-3)	R	0-110*	microinches	4	C	Gold	40	0.253
		0-200	microinches	4	Pm		80	0.117
TIN-NICKEL on Copper or Nickel (Sn-Ni/Cu)	N	0-1.5	mils	2	Tl	Copper	0.8	36.9
INDIUM on Brass (In/Br) (also for: INDIUM on Copper; see correction factor on page 31.)	N	0-900	microinches	4	Tl	Brass	600 or 300	0.0305

* The Carbon Source is not recommended for this measurement. Promethium should be used unless the base material is so thin that Promethium would penetrate through it.

NOTE: The above combinations and thickness ranges do not represent the limits of measuring capabilities of the MICRO-DERM. These have been prepared because they represent the most common applications of the MICRO-DERM.

British Units { 1.0 microinch = .000001 inch
1.0 mil = .001 inch

For Surface Measurements with "PS" or "HH" Series Probe Systems

COMBINATION	Mode	Thickness Limits	Units of Calibration	Range Switch	Isotope Used	Zero-Set Material	Approximate Checkpoint	Multiplier for Set-Up
COPPER and/or NICKEL on Epoxy (Cu/Epxy)	N	0-230	microinches	4	Pm	Epoxy	160	0.143
		0-1300	microinches	4	Tl	Epoxy	650	.0282
		0-1500	microinches	4	Ra	Epoxy	900	.0353
(See page A-6)		0-3.5	mils	2	Sr	Use your base mat'l	2	35.7
COPPER and/or NICKEL on Phenolic (Cu/Ph)	N	0-230	microinches	4	Pm	Phenolic	160	0.143
		0-1300	microinches	4	Tl	Phenolic	650	.0282
		0-1500	microinches	4	Ra	Phenolic	900	.0353
(See page A-6)		0-3.5	mils	2	Sr	Use your base mat'l	2	35.7
COPPER or NICKEL on Aluminum (Cu/Al)	N	0-230	microinches	4	Pm	Aluminum	160	0.144
		1.0	mils	2	Tl		.7	34.3
		1.5	mils	2	Ra		1	34.7
		5	mils	2	Sr		2	25.8
PHOTO RESIST on Copper (P-R/Cu) (See page A-7)	R	Varies with type	mils	2	C	Copper	Varies with Resist type (See page A-7)	
			mils	2	Pm			
TIN on Copper (Sn/Cu) (also for: TIN on Brass; see correction factor on page 31.)	N	0-120*	microinches	4	C	Copper	80	0.278
		0-170	microinches	4	Pm		120	0.156
		0-900	microinches	4	Tl		680	.0256
		0-4	mils	2	Sr		2.5	29.93
TIN on Steel (Sn/Fe)	N	0-120*	microinches	4	C	Steel	80	0.278
		0-170	microinches	4	Pm		120	0.156
		0-900	microinches	4	Tl		680	.0256
		0-4	mils	2	Sr		2.5	29.93
CADMIUM on Steel (Cd/Fe) .80 MILS	N	0-160	microinches	4	Pm	Steel	130	.1685
		0-800	microinches	4	Tl		550	0.035
		0-1.6	mils	2	Ra		1	29.4
CADMIUM on Copper (Cd/Cu) (also for: CADMIUM on Brass)	N	0-160	microinches	4	Pm	Copper	130	.1685
		0-800	microinches	4	Tl		550	0.035
		0-1.6	mils	2	Ra		1	29.4
ZINC on Steel (Zn/Fe)	N	0-260	microinches	4	Pm	Steel	170	0.151
		0-1800	microinches	4	Tl		1000	.0314
CHROMIUM on Aluminum (Cr/Al)	N	0-0.4	mils	2	Pm	Aluminum	0.3	116
CHROMIUM on Copper (Cr/Cu)	R	0-0.5	mils	2	Pm	Copper	.32	155
		0-2	mils	2	Tl		1.6	25.5
TEFLON® on Monel (TFE/Mnl) (duPont #851-204+852-201)	R	0-1.2	mils	2	Pm	Monel	0.5	0.740

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For Measurements in Circuit Board Holes
(For use with Probe TH-1 and Guide THG only.)

COMBINATION (in plated thru-holes)	Mode	Thickness Limits	Units of Calibration	Range Switch	TH-1 Isotope	Zero-Set Material (in hole)	Approximate Checkpoint	Multiplier for Set-Up
COPPER on Epoxy (Cu/Epoxy)	N	0-3.5	mils	2	Sr	Uncoated Epoxy	1.5	25.5
GOLD on Copper (Au/Cu) (See page A-2)	N	0-70	microinches	4	Pm	Copper	60	1.083
		0-300	microinches	4	Tl	Copper	140	0.255
SOLDER on Copper	N	0-900	microinches	4	Tl	Copper	Write for information	

*The Carbon Source is not recommended for this measurement.

MICRO-DERM MD-3 CALIBRATION RANGES

METRIC: All calibrations are in µm unless otherwise indicated
1,0 µm = ,001mm

For Surface Measurements with "PS" or "HH" Series Probe Systems

COMBINATION	Mode	Thickness Limits	Range Switch	Isotope Used	Zero-Set Material	Approximate Checkpoint	Multiplier for Set-Up
GOLD on Nickel (Au/Ni) (also for: GOLD on Brass or Copper; see correction factor on page 31.) (See page A-2)	N	0-1,1*	2	C	Nickel	,75	21,1
		0-1,8	2	Pm		1,5	14,0
		0-8,6	2	Tl		5,5 or 2,5	3,42
		0-13	3	Ra		8	3,16
		0-30	3	Sr		17	3,24
GOLD on Kovar (Au/Kvr) (also for: GOLD on Invar; see correction factor on page 31.)	N	0-1,1*	2	C	Kovar	,75	21,1
		0-1,8	2	Pm		1,5	14,0
		0-8,6	2	Tl		5,5 or 2,5	3,42
		0-13	3	Ra		8	3,16
		0-30	3	Sr		17	3,24
GOLD on Steel (Au/Fe)	N	0-1,1*		C	Steel	,75	21,1
		0-1,8	2	Pm		1,5	14,0
		0-8,6	2	Tl		5,5 or 2,5	3,42
		0-13	3	Ra		8	3,16
		0-30	3	Sr		17	3,24
GOLD on Silver (Au/Ag) (See page A-1)	N	0-7,6	2	Tl	Silver	6	2,12
SILVER on Copper (Ag/Cu) (also for: SILVER on Brass or Nickel; see correction factor on page 31.)	N	0-2,2*	2	C	Copper	1,5	10,2
		0-3,0	2	Pm		2,3	7,28
		0-18	3	Tl		12	1,51
		0-28	3	Ra		19	1,53
SILVER on Kovar (Ag/Kvr) (also for: SILVER on Invar; see correction factor on page 31.)	N	0-3	2	Pm	Kovar	2,3	7,28
		0-18	3	Tl		12	1,51
		0-28	3	Ra		19	1,53
SILVER on Steel (Ag/Fe)	N	0-3	2	Pm	Steel	2,3	7,28
		0-18	3	Tl		12	1,51
		0-28	3	Ra		19	1,53
SILVER on Gold (Ag/Au) (see page A-3)	R	0-2,5*	2	C	Gold	1,9	9,49
SOLDER on Copper (Sn-Pb/Cu) (See page A-4)	N	0-3,5	2	Pm	Copper	2,2	17,6
		0-24	3	Tl		14	1,94
		0-30	3	Ra		25	1,40
COMPOSITION of Electroplated Solder (%SnPb) (See page A-4)	N	0-80% Linear Indicator gives lead percentage		Pm	Tin	60/40 (40% lead)	Not used
RHODIUM on Nickel or Copper (Rh/Ni)	N	0-1,5*	2	C	Copper	1,0	10,6
		0-2,8	2	Pm		2,0	8,86
		0-25	3	Tl		15	1,97
RHODIUM on Gold (Rh/Au) (See page A-3)	R	0-2.8*	2	C	Gold	1,0	9,96
		0-5,0	2	Pm		2,0	4,61
TIN-NICKEL on Copper or Nickel (Sn-Ni/Cu)	N	0-38	3	Tl	Copper	20	1,45
INDIUM on Brass (In/Br) (also for: INDIUM on Copper; see correction factor on page 31.)	N	0-23	3	Tl	Brass	75 or 15	1,20

* The Carbon Source is not recommended for this measurement. Promethium should be used unless the base material is so thin that Promethium would penetrate through it.

NOTE: The above combinations and thickness ranges do not represent the limits of measuring capabilities of the MICRO-DERM. These have been prepared because they represent the most common applications of the MICRO-DERM.

METRIC: All calibrations are in microns unless otherwise indicated
1,0 micron = ,001mm

For Surface Measurements with "PS" or "HH" Series Probe Systems

COMBINATION	Mode	Thickness Limits	Range Switch	Isotope Used	Zero-Set Material	Approximate Checkpoint	Multiplier for Set-Up
COPPER and/or NICKEL on Epoxy (Cu/Epxy)	N	0-5,8	2	Pm	Epoxy	4,0	5,63
		0-32	3	Tl	Epoxy	16	1,11
		0-38	3	Ra	Epoxy	23	1,39
		0-90	4	Sr	Use your base mat'l	50	1,41
COPPER and/or NICKEL on Phenolic (Cu/Ph)	N	0-5,8	2	Pm	Phenolic	4,0	5,63
		0-32	3	Tl	Phenolic	16	1,11
		0-38	3	Ra	Phenolic	23	1,39
		0-90	4	Sr	Use your base mat'l	50	1,41
COPPER or NICKEL on Aluminum (Cu/Al)	N	0-5,8	2	Pm	Aluminum	4,0	5,67
		0-25	3	Tl		16	1,35
		0-38	3	Ra		23	1,37
		0-90	4	Sr		50	1,02
PHOTO RESIST on Copper (See page A-7)	R	Varies	3	C & Pm	Copper	Varies (See p. A-7)	
TIN on Copper (Sn/Cu) (also for: TIN on Brass; see correction factor on page 31.)	N	0-3*	2	C	Copper	2	10,9
		0-4,3	2	Pm		3	6,14
		0-23	3	Tl		17	1,01
		0-105	4	Sr		63	1,18
TIN on Steel (Sn/Fe)	N	0-3*	2	C	Steel	2	10,9
		0-4,3	2	Pm		3	6,14
		0-23	3	Tl		17	1,01
		0-105	4	Sr		63	1,18
CADMIUM on Steel (Cd/Fe)	N	0-4	2	Pm	Steel	3,3	6,63
		0-20	3	Tl		14	1,38
		0-40	3	Ra		25	1,16
CADMIUM on Copper (Cd/Cu) (also for: CADMIUM on Brass)	N	0-4	2	Pm	Copper	3,3	6,63
		0-20	3	Tl		14	1,38
		0-40	3	Ra		25	1,16
ZINC on Steel (Zn/Fe)	N	0-6,5	2	Pm	Steel	4,3	5,94
		0-45	3	Tl		25	1,24
CHROMIUM on Aluminum (Cr/Al)	N	0-10	3	Pm	Aluminum	7,5	4,57
CHROMIUM on Copper (Cr/Cu)	R	0-12,5	3	Pm	Copper	8,1	6,10
		0-50	3	Tl		40	1,00
TEFLON® on Monel (TFE/Mnl) (duPont #851-204+852-201)	R	0-30	3	Pm	Monel	13	1,306

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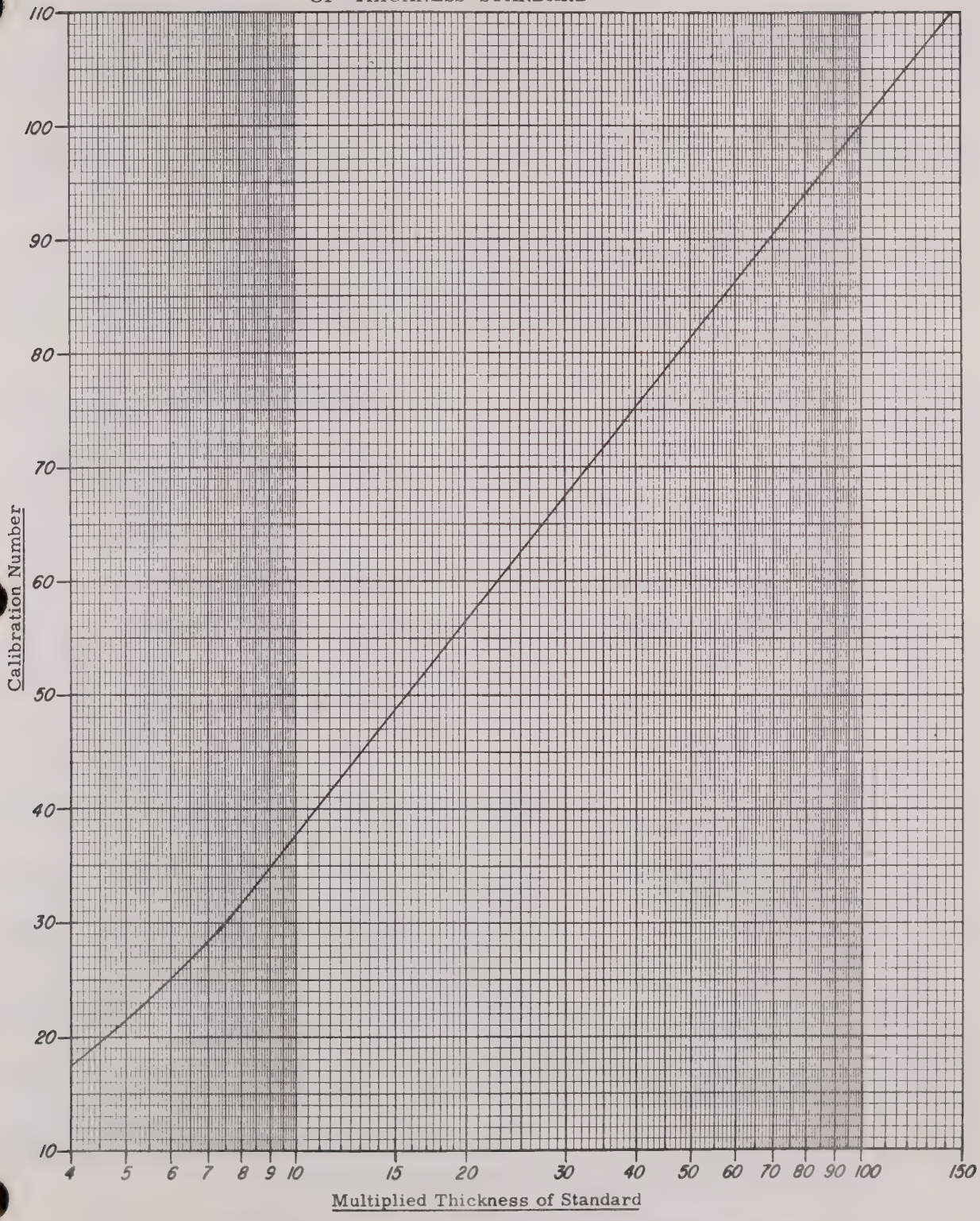
For Measurements in Circuit Board Holes
(For use with Probe TH-1 and Guide THG only.)

COMBINATION (in plated thru-holes)	Mode	Thickness Limits	Range Switch	TH-1 Isotope	Zero-Set Material	Approximate Checkpoint	Multiplier for Set-Up
COPPER on Epoxy (Cu/Epoxy)	N	0-90	3	Sr	Uncoated Epoxy	40	1,00
GOLD on Copper (Au/Cu) (See page A-2)	N	0-1,8	2	Pm	Copper	1,5	42,6
		0-7,6	2	Tl	Copper	3,5	10,04
SOLDER on Copper	N	0-23	3	Tl	Copper	Write for information	

*The Carbon Source is not recommended for this measurement.

GRAPH FOR DETERMINING CALIBRATION NUMBER
OF THICKNESS STANDARD



(Thickness of Standard Times Multiplier from pages 20-23.)

3-4. SELECTION OF PROPER ISOTOPE

Check the table on pages 20 through 23 to see if thickness limits are listed for the combination you wish to measure. Use the isotope that is recommended for your desired measuring range, but note that the isotope must also be chosen so it will not penetrate your base material. This is important when measuring on foils or plated bases; see pages A-1 through A-7 in the Appendix for detailed information on several base materials.

Use the table below if the thickness limits are not available for your particular combination, and you wish to choose the proper isotope for any of the following purposes:

(a) To draw a Calibration Curve.
(b) To use the instrument as a "Go, No-Go" Gauge.
(c) To make rough comparisons of thickness of available samples.
(d) To be sure you do not penetrate a given material. (Add at least 25% to the values below; see pages A-1 through A-7 for more detailed information.)

Note the values in the chart below are generally much thicker than the thickness limits for digital direct-reading measurements. This is because the chart below includes measurements which are out of the direct-reading "logarithmic range" of the isotope. To get the approximate direct-reading upper limit, subtract about 25% from the values below. Thicknesses above this reduced value cannot be read directly on the THICKNESS display and can only be read by making up a special calibration curve.

Approximate Maximum Measuring Ability of Isotopes

The upper numbers are microinches: 1 microinch = .000001"
The lower numbers, shaded, are in metric units: 1μm = .001mm

Coating Materials (and their atomic numbers)	Approximate Maximum Measuring Ability (using special calibration curve)				
	C	Pm	Tl	Ra	Sr
Gold (79); Lead (82); Platinum (78) Tungsten (74); Tantalum (73)	70 1,8μm	110 2,8μm	450 13μm	600 15μm	1300 33μm
Cadmium (48); Tin (50); Silver (47); Rhodium (45); Palladium (46)	120 3μm	200 5μm	1200 30μm	2000 50μm	4000 100μm
Bronze, Brass, Copper (29); Zinc (30); Nickel (28); Steel, Iron (26)	200 5μm	350 9μm	2200 56μm	3500 90μm	8000 200μm
Chromium (24); Titanium (22)	300 7.5μm	500 13½ μm	3000 75μm	4000 100μm	10000 250μm
Aluminum (13); Magnesium (12); Window Glass	700 18μm	1200 30μm	9000 200μm	16000 400μm	30000 760μm
Most Plastics and some Paints	1500 38μm	3000 76μm	14000 350μm	20000 500μm	40000 1000μm

NOTE: See pages A-11 and A-12 for procedure used to determine if a combination is measurable with the MICRO-DERM.

3-5. DETERMINING PROPER RATE SWITCH AND TIMER CONTROL SETTINGS

Purpose of RATE switch

This switch makes it possible to use a wide range of counting rates, from very low rates (with small apertures) to very high rates (with large apertures) and still enables the ZERO and CAL controls to adjust the zero and the checkpoint-standard readings. The reason the RATE switch is needed is because the ZERO and CAL controls have a limited range of adjustment. The RATE switch serves only to allow the two controls to be set and there are usually two or even three different RATE switch positions which will work.

There is no specific RATE switch position which should be used for a given set-up; whichever position allows the controls to be set is all right. In general, however, slightly better results will be obtained using the lowest-numbered RATE position which allows the controls to be set. If you change the RATE switch setting, you must restandardize (page 16) before taking measurements.

Procedure for Determining Settings

A trial and error procedure is used for determining the proper RATE switch position. Proceed as follows:

1. Perform steps 1 through 3 as outlined in Table 3-3 (page 16).
2. Set RANGE switch to LINEAR
3. Set MODE switch to NORMAL or REVERSE, depending on the coating-base combination (see pages 20 through 23).

NOTE

In the list on pages 20 through 23, N represents NORMAL and R is REVERSE.

4. Set RATE switch to position 1 and TIMER control to 1/8 minute.
5. Place bare standard in proper position for measurement with Probe System.
6. Turn ZERO control fully counterclockwise.
7. Press and release RESET button.

   a) For Normal Mode: When digits in THICKNESS display light up, and a "+" readout appears (whether or not over-range), switch RATE to position 2 and press RESET switch. If "+" readout still appears, try RATE position 3, etc., until a "-" readout appears. Leave the RATE switch in this position. Now hold in RESET switch and turn ZERO control for reading of 00.0.

   b) For Reverse Mode: Use same procedure as in a) except for "+" read "-" and for "-" read "+".

8. Remove the sample of bare material and place the proper Thickness Standard in position for measurement.

9. If it has not been already supplied, find the "Calibration Number" for the particular Thickness Standard being used. Do this by first multiplying the thickness by the multiplying factor listed on pages 20 through 23, then looking up the "Calibration Number" on the graph on page 25.

10. Press the RESET button and then allow the unit to time out.

11. After the THICKNESS display lights up, hold the RESET button in and use the CAL control to set the reading on the THICKNESS display to the "Calibration Number." The adjustment should be made with the CAL control digi-dial set no lower than 100. If you cannot do this, see below: If you <u>can</u> do this, proceed to step 12.

NOTE

The CAL control should never be set for a digi-dial reading less than 100. If the only RATE switch setting that will work in a) below without forcing you to b) requires a digi-dial reading less than 100, then and only then may it be set below 100.

a) <u>If THICKNESS reading is too high</u> ("+" or "over-range +") and you cannot bring it down even by turning CAL control counterclockwise to 100, repeat steps 5 through 11, using a RATE switch setting one number higher than you are now using. If you still cannot set the reading in step 11, follow 11a or 11b, whichever is then applicable, keeping the above note in mind.

b) <u>If THICKNESS reading is too low</u> and you cannot bring it up, even by turning CAL control fully clockwise, go back and check again that the next <u>lower</u> RATE position will not work in steps 5-11. If it will not, you will not be able to set up the MICRO-DERM. Either the combination is too close in atomic properties to measure or there is something wrong. Go over each individual step carefully. Check particularly that you have calculated the "Calibration Number" properly — See page 24. If you still cannot set up, run through the routine service procedures (pages 33 through 35).

12. If you are able to set the THICKNESS display to read the "Calibration Number" in step 11, you have found the proper RATE switch position to use for this particular measuring set-up. This same rate is used no matter what measuring time is used.

The choice of time used depends on the level of reproducibility desired — see page 29 for a more detailed discussion. However, since the RATE position gives a rough indication of how many counts are being received, the following can be used as a <u>rough</u> guide to the time to be used:

If you are using RATE	1	2	3	4	5	6	7
Set TIMER control to	2	1	1/2	1/2	1/4	1/4	1/8

3-6. EFFECT OF CHANGING MEASURING TIME

Choice of Measuring Time:

Since the Beta-rays are emitted from the Radioisotope Source in a random manner, successive readings will vary slightly. This normal variation is due to the fact that the MICRO-DERM is totaling the number of Beta-rays reflected by the sample for the particular preset time period. The longer the time period, the more Beta-rays the MICRO-DERM will count and the greater will be the precision of counting. The reproducibility of MICRO-DERM readings is directly dependent on the emission of the Source and the Beta-rays counted; therefore, the reproducibility of successive MICRO-DERM readings depends on the measuring time chosen. (Longer times give better reproducibility.)

In general, a 1/2-minute measuring time is recommended. This time works out well for most purposes, but you may wish to increase or decrease it. The best procedure is to first try measurements at 1/2 minute and then change the time to fit your requirements.

How to Improve Reproducibility of Readings:

Should you be using a particular measuring time (TIMER control setting), RATE switch position, etc., and you find that your readings are not sufficiently reproducible to meet your needs: Improve the statistics and reproducibility by measuring at twice the time. (However, you must now standardize at four times the new measurement time, as described on page 30.) It is not necessary to change RATE switch positions. For example, if you have been using 1/2 minute and Rate #2, you could change to 1 minute, still at Rate #2, or 2 minutes still at Rate #2.

You will probably wish to use a longer measuring time than 1/2 minute if your measurements are made using small apertures (less than .020") or your combinations are close in atomic number (for example, silver on copper, or chrome on copper). Again, you must use a longer standardization time.

Reproducibility can also be improved by using a larger measuring opening.

How to Make Readings in Shorter Measuring Time:

If you wish to make quicker measurements, you may measure using half the time. For example, if the time for a measurement is 1/2 minute, you can also use 1/4 minute. The readings will not be as reproducible as 1/2-minute readings, but you will get a faster measurement of the thickness on the piece.

A shorter measuring time is often used when there are many parts to be measured. The slight difference in readings may be eliminated by taking two readings on any piece which falls close to the allowable thickness limit and using the average of the readings. Thus most pieces can be checked at the shorter time and only the close readings need take extra time. - Note that if this procedure is used, you must still use the longer time to set the standards, as described on page 30.

Time Used to Take Readings on the Standards:

Since the standards should be set with more accuracy than any other thickness reading, set them using a TIMER control setting that is four times the time you will use for measuring. (This will cut down the random fluctuations in source output which affect the setting of the standards as well as thickness readings.) After setting the standards with a longer time, simply reset the TIMER control to your desired measuring time and proceed to take measurements.

In addition to using a longer time to set the standards, you may wish to average several readings on each standard. See procedure below.

3-7. OPTIONAL PROCEDURE FOR AVERAGING SETTINGS OF CHECKPOINTS

For most applications, the normal variation in successive MICRO-DERM readings is small enough to be ignored, since the standards are set with a time interval that is four times longer than that used for measuring the unknown pieces. To obtain still greater accuracy you can also average readings so the unit is set to the average of several readings.

Use the following procedure:

1. Standardize your MICRO-DERM as described in step 5 of Table 3-3 (pages 16-18). Leave the RANGE switch in the proper direct reading position.
2. Place the base material standard on the measuring opening for a second time.
3. Push in the RESET button, release it and wait for the time period to elapse.
4. After the THICKNESS display lights up, hold in the RESET button and adjust the ZERO control so that the reading on the neon THICKNESS display is exactly zero. Record the numbers which appear in the little window above the ZERO knob. (These are "digi-dial" readings).
5. Repeat steps 3 and 4 two more times. (If still greater precision is desired, you may want to take even more readings.)
6. Calculate the average of the ZERO digi-dial readings obtained in steps 4 and 5. Set the ZERO control to this average value and lock it.
7. Place the upper checkpoint Thickness Standard on the measuring opening.
8. Push in the RESET button, release it and wait for the time period to elapse.
9. After the THICKNESS display comes on, hold in the RESET button and adjust the CAL control so that the reading on the THICKNESS display corresponds to the thickness standard. Now record the CAL digi-dial reading.
10. Repeat steps 8 and 9 two more times. (If still greater precision is desired, you may want to take even more readings.)
11. Calculate the average of the CAL digi-dial readings obtained in steps 9 and 10. Set the CAL control to this average value and lock it.

Actual Measurement:

Now reset the TIMER control to its normal measuring time and make measurements on the parts to be measured, reading the thicknesss value directly from the THICKNESS display.

NOTES

(1) In the above procedure, note that the CAL control is used to set the actual thickness of the standard (not the calibration number as in the normal operating procedure on page 17). Averaging of readings is done only by resetting the ZERO and CAL controls. (The CHECK-POINT control serves only to "translate" a given linear calibration number to its proper direct-reading thickness equivalent and whenever you re-standardize, the CHECKPOINT control should be set only once in accordance with the procedure on page 17.)

(2) When re-standardizing the MICRO-DERM, be sure to actually repeat readings on Thickness Standards. This will result in greater accuracy than simply using the previous "digi-dial" readings.

3-8. APPLYING BASE MATERIAL CORRECTIONS

The instrument is always adjusted to read zero using the base material sample supplied as a standard (not a bare production piece). After final settings are made, take a reading on a bare* production piece with the MICRO-DERM set for direct readings of thickness. If this reading is not close to zero, then this reading should be used as a correction factor to correct all subsequent readings on production coated parts. (However, this correction is often small and can be neglected.)

a. If the reading on your bare production part is positive (+), then subtract this amount from all readings on coated parts.

b. If the reading is negative (-), find out the exact value by temporarily switching the MODE switch to the opposite position. After finding the value, return the MODE switch to its proper position and then add the value found to all readings on coated parts.

The correction factor should never exceed approximately 1/4 the total measuring range ("Thickness Limits") listed on pages 20 through 23. If the correction factor is too large, you must use standards which are closer in properties to your particular base material.

In all cases, the use of a correction factor can be eliminated if you prepare standards (both bare and coated) which are identical to your production pieces.

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* "Bare" refers to the condition before plating of the layer to be measured. For example if you are measuring gold over silver-plated brass, the "bare" condition refers to the silver-plated piece and not the brass.

NOTES

Section 4

ROUTINE SERVICE PROCEDURES

4-1. INTRODUCTION

The MICRO-DERM is designed to operate properly under a wide range of conditions and requires minimum service. Changes in operating conditions, isotope strength, etc. are compensated for when the instrument is standardized, but the procedures that follow will help to keep your MICRO-DERM operating at top efficiency.

4-2. REMOVING MICRO-DERM COVER

When necessary, access to the interior of the MICRO-DERM is gained by removing the 11 silver Phillips-head screws on the top and rear of the cover and then lifting it off.

WARNING

High voltages exist in this unit. Be sure to unplug the line cord before removing the cover.

4-3. HIGH VOLTAGE CHECK

The high voltage supplied by the MICRO-DERM to the Geiger Tube in the probe should be checked at 3-month intervals. Keeping the RESET button depressed, hold the H.V. TEST switch (item 6, figure 3-2) in its lower position and note the reading on the THICKNESS display. It should be between 910 and 930. (This reading corresponds to the high voltage value which should range between 910 and 930 volts.) If necessary to readjust the high voltage, remove the cover, set the TIMER switch to 2 minutes, then press and release the RESET button. Holding the H.V. TEST switch down, readjust the high voltage during this 2-minute interval by carefully adjusting the left-hand trimpot (looking at the unit from the front) on Board No. 4 (the rear-most board inside the unit).

WARNING

High voltages exist on Board No. 4. Be very careful.

An adjustable resistor, located on the right side of Board No. 4, can be used to recalibrate the MICRO-DERM readout when required. You must use an electrostatic voltmeter to perform this calibration. Proceed as follows:

a. Connect the electrostatic voltmeter to the PROBE connector at the front of the MICRO-DERM.

b. First set the high voltage to exactly 920 volts by adjusting the left-hand trimpot until the external voltmeter reads 920 volts. Now remove the voltmeter.

c. With the TIMER switch set to 2 minutes, hold the H. V. TEST switch in its lower position, press and release the RESET button, and adjust the right-hand trimpot until the reading on the THICKNESS display is exactly 920. This calibrates the meter circuit.

4-4. TEST OPERATION

The RATE switch is equipped with a TEST position which permits a test count to be made. With the RATE switch set to this TEST position and the POLARITY switch set to NORMAL, press the RESET button and wait for the time period to elapse. The reading on the THICKNESS display should be approximately 900 to 1100 (disregarding the decimal point). This test is useful mainly as a check to see if the unit is counting at all; the exact readout is not significant.

4-5. THICKNESS DISPLAY ZERO ADJUST

The zero adjust of the THICKNESS display should be checked periodically. With the RANGE switch set to LINEAR, check the reading obtained when the MODE switch is switched from NORMAL to REVERSE. If the digital reading is the same (within 0.1), the zero adjust is normal. If the two readings differ by 0.2 or more, readjust the zero setting in the THICKNESS display as follows:

a. Remove the top cover of the MD-3 (page 33).

b. Pull out the front window (plastic bezel) of the THICKNESS display.

c. Apply power to the MD-3 and let it warm up for 15 minutes.

d. MD-3's using Weston displays:

1. Short pins 10(-) and 2(+) on the top (analog) connector at the rear of the display.

2. From the front of the MD-3, rotate the left zero adjust pot in the THICKNESS display with a screwdriver until the digital reading is 00.0 with the (+) polarity lamp just on.

e. MD-3's using Electro-Numeric displays:

1. Same as step 1 above, but short pins 10(-) and A(+) on analog connector.

2. Same as step 2 above, but zero adjust pot is on right side.

4-6. STANDARDS

The solid bare standards used to set the zero, and any other solid samples used, should be polished by rubbing them on a plain piece of paper. If a soft solid sample such as copper is badly scratched, metallographic paper should be used to polish it.

Plated thickness standards should never be polished since this would change their thickness. If these standards get dirty or covered with grease, they may be washed with a non-abrasive soap and water.

Thickness standards should have their thickness checked occasionally, depending on the wear to which they are subjected. This can be done by buying two sets of standards; one set of standards would be used for routine setting of the MICRO-DERM while the other would be put aside and used only for checking the thickness of the first set. Alternatively, they can be checked by UPA (contact Sales Dept. for prices and details).

4-7. PRINTED CIRCUIT BOARD REPLACEMENT

There are four circuit boards inside the unit, each with a separate function. Board No. 1 is the counting circuit, board No. 2 is the timer, board No. 3 is the linear-to-direct reading converter, and board number 4 contains the low and high voltage power supplies. These boards may be easily replaced by the user. If any one is suspected of not working, try changing it with another (good) board of the same number and see if the trouble clears up. Printed circuit board repair can best be done by UPA.

4-8. REPLACEMENT OF ISOTOPE SOURCES

After a period of time equal to one half-life, any Source will produce one-half the number of counts it produced originally. It will decay in this natural manner whether it is used or not. Table 4-1 indicates the half-life of different sources.

The effect of this reduction in output is to increase the measuring time necessary to obtain acceptable reproducibility of readings. To put it another way, as the isotope decays, the statistical variation from reading-to-reading will increase if the measuring time is not increased. The RATE switch setting for measurement can always be found by running through the RATE switch procedures (page 27). (You can often simply set the RATE switch one position lower than the one you were using.)

The time interval at which this effect will be noticed depends on the half life of the Isotope. It should be at least several years before a change is observed in Sr-90 (half-life 28 years), while it will be several months before a change is observed in Pm-147 (half-life 2.6 years). It should be noted that the slight, day-by-day decay of the Isotope is automatically compensated for when the instrument is standardized.

SEE TABLE 4-1

Most users replace their Isotope after the half-life has been reached. This depends on the particular set-up being used and the amount of variation permitted. If a very short time is involved, the time can simply be doubled without any loss in accuracy. However, if a long measuring time is involved, it would be of advantage to replace the Source instead of increasing the measuring time. Replacement sources are available from UPA.

In addition to normal radioactive decay, two other changes may significantly affect source performance: a. Accumulation of dust or dirt in the small tip of the source can seriously lower its output. b. Damage to the source tip, even though it may appear slight to the eye, may result in very poor MICRO-DERM performance.

Table 4-1

HALF-LIFE OF ISOTOPE SOURCES

Symbol	Isotope-Source	Half-Life
C	Carbon-24	5500 years
- Pm	Promethium-147	2.6 years
- TI	Thallium-204	3.5 years
Ra	Radium-D	20 years
Sr	Strontium-90	28 years

4-9. ELECTRONIC SERVICING

Should electronic servicing of the MICRO-DERM basic unit be required, this can best be done by the UPA Service Department. UPA can loan a rental unit which can be used while the customer's unit is being repaired.

NO DIAGRAMS

APPENDIX A

Measurement of Coatings over Silverplate

The measurement of coatings on silver-plated copper alloys can easily be accomplished with the MICRO-DERM in the case where the silver deposit is considerably thicker than the topmost coating. In this case, it is important that the appropriate Source be chosen so that the Beta-rays will "see" the silver layer as being infinitely thick (that is, the Beta-rays will not penetrate the silver layer). The choice of Source depends on both the silver thickness and the topmost coating thickness. The Source chosen should have an energy which will allow your measurements to fall within the "Thickness Limits" listed on pages 20-23 and still not penetrate the base silver as listed below.

The following table indicates the minimum thickness required so that the Beta-rays from the indicated Sources will not penetrate the silver layer:

Source Used	Approximate Minimum Silver Thickness Required (mils)	(microns)
Carbon	0.15	3,8
Promethium	0.25	6,3
Thallium	1.4	35
Radium	2.5	63

NOTES:

(1) In all cases a reading should be taken, with the unit set up to measure over infinite silver, on the bare silver piece before plating. (This is described on page 31.) This will check that your silver is the same as our "infinite" base silver standards. Any correction factor obtained by this procedure should be used on all subsequent readings.

(2) If the silver is less than the minimum thickness required for the corresponding isotope, then it may still be possible to measure the coating thickness, providing that the silver is uniform from one piece to the next. In this procedure, one simply takes a reading on several silver-plated pieces in a manner similar to that described in note No. 1. In general, this results in a constant thickness to be added to subsequent readings. (See page 31.)

(3) If the silver is too thin to act as a base, and it is not uniform, then it is theoretically possible to use two radioisotopes; one of higher energy and the other of lower energy (such as Thallium-204 and Promethium-147, respectively). A reading is first taken with one of the isotopes, and then with the other isotope. The low-energy isotope will be especially sensitive to the top layer (for example, gold); whereas the higher-energy isotope will "feel" both the gold and silver layers. By correlating the readings taken by the two isotopes, it has been possible in the laboratory to measure both the gold and silver thicknesses. So far this method has not been refined for field use over a wide range of coating thicknesses.

APPENDIX B

Measurement of Coatings on Thin Copper Layers

Measurement of coatings over thin copper can easily be accomplished with the MICRO-DERM in the case where the copper layer is considerably thicker than the coating deposit. In this case, it is important that the appropriate Source be chosen so that the Beta-rays will "see" the copper layer as being infinitely thick (that is, the Beta-rays will not penetrate the copper layer). The choice of Source depends on both the copper thickness and the coating thickness - see pp. 20-23 for listing of thickness limits and multiplication factors for various coatings.

The following table indicates the minimum thickness required so that the Beta-rays from the indicated Sources will not penetrate the copper layer. (Since nickel is close to copper in properties, it also indicates the minimum nickel, or total copper plus nickel, thickness.)

Source Used	Approximate Minimum Copper or Nickel Thickness Required	
	mils	microns
Carbon	0.25	7.5
Promethium	0.4	10
Thallium	2.7	68
Radium	4.5	125
Strontium	9	250

NOTES:

(1) The above table assumes that the copper layer is on a base material whose atomic number is considerably different from that of copper (such as phenolic, epoxy, plastic or aluminum bases). However, if the base material is close to copper in atomic number (for example, steel), then the "minimum thicknesses" will be considerably less than in the above table and you may simply use a correction factor (see page 31).

(2) In all cases a reading should be taken, with the unit set up to measure, on the bare copper piece in the condition just before final plating. (The procedure is described on page 31.) This will check that your copper is the same as UPA standards. Any correction factor obtained by this procedure should be used on all subsequent readings.

(3) If the copper is less than the minimum thickness required for the corresponding isotope, then it may still be possible to measure the coating thickness, providing that the copper is reasonably uniform from one piece to the next. In this procedure, one simply takes a reading on several copper-plated pieces in a manner similar to that described in note No. 2. In general, this results in a constant thickness to be added to subsequent readings (see page 31.).

APPENDIX C

Measurement of Coatings on Gold Layers

Measurement of coatings over thin gold can easily be accomplished with the MICRO-DERM in the case where the gold layer is thicker than the coating deposit. In this case, it is important that the appropriate Source be chosen so that the Beta-rays will "see" the gold layer as being infinitely thick (that is, the Beta-rays will not penetrate the gold layer). The choice of Source depends on both the gold thickness and the coating thickness.

The following table indicates the minimum thickness required so that the Beta-rays from the indicated Sources will not penetrate a gold layer:

Source Used	Approximate Minimum Gold Thickness Required (mils)	(microns)
Carbon	0.10	2,5
Promethium	0.15	3,8
Thallium	0.8	2,0

Measurement of Rhodium over Gold

The calibrations available for this measurement are listed on pages 20 through 23 . When using these calibrations, a reading should be taken (with the unit set up to measure rhodium over gold) on the bare gold piece before rhodium plating. (The procedure is described on page 31 .) This will check that your gold is the same as our standards. Any correction factor obtained by this procedure should be used on all subsequent readings.

If the gold is less than the thickness required for a particular isotope:

1). 30-100% of required thickness.
There is still a possibility of measuring the rhodium providing that the gold is uniform from one piece to the next: in this procedure, one simply takes a reading on several gold-plated pieces in a manner similar to that described above. In general, this results in a constant thickness to be subtracted from subsequent readings. If the gold is not absolutely uniform, then readings must be taken on the same exact spot before and after rhodium plating.

2). 10-30% of required thickness.
The measurement cannot be made because gold in this thickness range appears to have the same beta-backscatter properties as rhodium.

3). 2-10% of required thickness.
If the gold is uniform from one piece to the next, a special calibration can be made for the particular thickness of gold interlayer you have.

4). If the gold is extremely thin (less than about 2% of the required thickness), then you can set up to measure rhodium over nickel or copper and use a correction factor to eliminate the effect of the gold. If the gold is not absolutely uniform, this will require taking readings on a particular spot before and after rhodium plating.

APPENDIX D

Measurement of Solder (Tin-Lead) Coatings

Solder Thickness

All Unit Process Assemblies' solder thickness standards and calibrations are made for the measurement of 60/40 (60% tin and 40% lead) coatings, but they may be used to measure alloys ranging from approximately 63/37 to 58/42.

Measurement of the thickness of solder coatings on copper is accomplished in the same manner as other coatings, using the calibrations listed on pages 20-23. Please also see page A-2 for the minimum copper thicknesses required for measurement with the various isotopes.

Solder Composition

The measurement of composition is accomplished by using an isotope which will not penetrate through the solder coating to the base material. Best results are obtained by the use of the Promethium isotope whenever the coating is over 180 microinches (4,6 microns) thick. If the coating is less than 180 microinches (4,6 microns) and over 100 microinches (2,5 microns), the Carbon Isotope should be used. It is important that the coating be above the minimum thickness to obtain proper composition readings. If the deposit is too thin, it will appear to have a higher percentage of tin. In the case of an extremely thin deposit, the readings will be negative.

Standardization is accomplished by using the ZERO control to first set the "tin" reading to "00.0", and then using the CAL control to set the reading to the per cent lead of the standard (for example, a 60/40 standard would be set to "40.0"). The reading for this calibration indicates per cent lead directly and no multiplier is used at any time. (For example, a reading of "42.7" indicates an alloy of 57.3/42.7). The range switch is left set in the LINEAR position and the CHECKPOINT control is not used and has no effect on this calibration.

The "tin" standard and the standard of known composition should occasionally be polished by rubbing them over a piece of soft facial tissue. If the standard is smooth, do not use anything more abrasive than paper. This is to remove any oxide coating which may be present. If the standard is dented, damaged, or scratched, it should be polished with 600 grit metallographic paper and then final polished with soft facial tissue. Note that only the composition standards and bare samples made of solid material should be polished. Regular plated Thickness Standards should never be polished as it would change their thickness.

Since UPA composition standards are based on an electroplated deposit of average density, coatings with a higher density than UPA standards may appear to have a higher percentage of lead. Because of the possibility of density variations, MICRO-DERM readings on your deposits should be cross-checked by destructive means to be sure you are getting correct readings. If the density of your deposit does not correspond to UPA standards, use a sample of your deposit of known composition as a standard. Please also note that the MICRO-DERM is only sensitive to the composition of the topmost layer of solder. The maximum penetration is 100 microinches (2,5 microns) for Carbon and 180 microinches (4,6 microns) for Promethium. If your coating is not uniform in composition, MICRO-DERM composition measurements will only be representative of the topmost part of the coating.

As stated above, UPA standards are used for measurement of electroplated solder. They may or may not be applicable to a cast alloy or a flowed or hot-dipped coating, depending on the particular properties of the solder being measured.

APPENDIX E

Measurement of Tin-Nickel Coatings

Measurement of the thickness of tin-nickel coatings on copper or nickel is accomplished in the same manner as other coatings. The calibration available is listed on pages 20 through 23.

The calibration has been made for the measurement of 65/35 (65% tin and 35% nickel) coatings, but it may be used to measure alloys ranging from approximately 60/40 to 70/30. This should not present a problem since the tin-nickel deposit is generally very stable.

The MICRO-DERM is always standardized using the standards supplied: a piece of bare copper to set the zero and a plated standard of known thickness to set the CAL and CHECKPOINT controls. In all cases, a reading should be taken, with the unit set up to measure tin-nickel over copper, on a bare piece in the condition it is in just before tin-nickel plating. (The procedure is described on page 31 .) This will check that your base copper or nickel is the same as our standards. Any correction factor obtained by this procedure should be used on all subsequent readings (see page 31).

Please also see page A-2 for the minimum copper thicknesses required for measurement with the Thallium Isotope.

APPENDIX F

Measurement of Thick Copper on Epoxy or Plastics

There are several calibration ranges available for the measurement of copper on plastics; see pages 20-23 for complete listings. When the copper is thicker than 1.5 mils (40 microns), however, the Strontium Isotope must be used.

A special copper foil thickness standard is used with the Strontium isotope. Fold the protective cardboard out of the way so that the copper foil is directly up against the base material. When PS-6 or PS-10 probe systems are used, the probe pin should press the base material firmly against the copper foil so the foil is in turn pressed against the aperture plate. Once the foil is properly positioned, it should be used the same way as a plated standard.

CAUTION

Handle foil thickness standards with care.

In order to appear infinite to the Strontium source, the circuit board must be at least .050" (1,3mm) thick. On single clad boards, back up the board with enough board material to make .050" (1,3mm) total thickness. On double-clad boards thinner than .050 (1,3mm) the effect of the copper on the reverse can be kept constant by backing up the reverse with a piece of thick copper. This back-up copper should be used when standardizing, as well as when measuring and will eliminate measurement error caused by variations in the reverse side copper thickness. The backup technique will work only if the board is thicker than .006" (0,15mm).

NOTE

The Strontium isotope will penetrate the edges of standard aperture plates and specimen masks smaller than .062" (1,57mm) and will greatly increase the effective area of the opening. Special apertures are available (marked "Sr") which have been designed with thicker edges to minimize this effect. These plates, however, give poorer performance and it is generally necessary to use a 1-minute measuring time to get satisfactory reproducibility. For circular openings .047" (1,2mm) and less diameter, or slit openings .020" (,51mm) and less wide, performance drops off very significantly and it is generally necessary to use 2 minutes to get satisfactory reproducibility.

Photo Resist Thickness Standards and Calibrations are available from stock as listed below. Generally, Thickness Standards are supplied to you in accordance with the particular brand type of resist requested (KPR2, KMER, AZ119, etc.). However, several types of photo resist may be measured using the same multiplier. Photo resist standards supplied are applied on the base material requested (Copper, Kovar, or Stainless Steel). For nickel bases, use copper based standards.

Isotope: Often the resist coatings are so thin that Carbon must be used. However, if you know that the coating is thicker than about 0.2 mil (5 microns), you should use the Promethium isotope since the higher output of Promethium will in general give better reproducibility. When measuring with a Carbon isotope (Miniature Probe configuration) it is advantageous to use the Model HH-2B. This probe has two sources in it and thus has better reproducibility than a standard Carbon Source. (The Promethium Miniature Probe is also available in the Model HH-2B two-source probe, but the double activity is not as important since standard Promethium Sources give satisfactory performance for this application.)

For all Photo Resist measurements the mode switch is set to REVERSE when standardizing and taking measurements.

Applicable Types of Photo Resist	Thickness Limits	Units of Calibration	Range Switch	Multiplier for Set-Up	Isotope Used
KPR-1, -2, -3	0-1 0-25	mil microns	1 3	27.5 1,08	C
KPR-1, -2, -3 & Dynachem 3118H	0-2.2 0-50	mils microns	2 3	14.1 0,553	Pm
Shipley*AZ-345, -340 and 119 also Riston	0-1.2 0-30	mils microns	1 3	24.9 0,98	Pm
KMER and KTFR also Waycoat PF and 20	0-1 0-25	mil microns	1 3	21.4 0,834	C
	0-1.7 0-45	mils microns	1 3	10.4 0,41	Pm

* These scales should be used to measure only photo resist which has been "cured".

Generally, resists with a dye require standards prepared with that particular dye as the solids content changes the apparent atomic number of the resist.

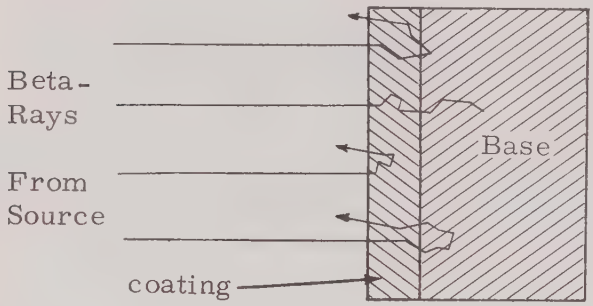
When ordering, specify both the type of resist and base material, in addition to the isotope which will be used. If the particular brand type or thickness range of photo resist is not listed in the above table, please request our Bulletin PR/TSPS for information about special standards.

When measuring thicker resist coatings, over approximately 0.2 mil (5 microns), it should be pointed out that the DERMITRON and ACCUDERM Thickness Testers are capable of measuring these thicker coatings on appropriate bases.

APPENDIX H

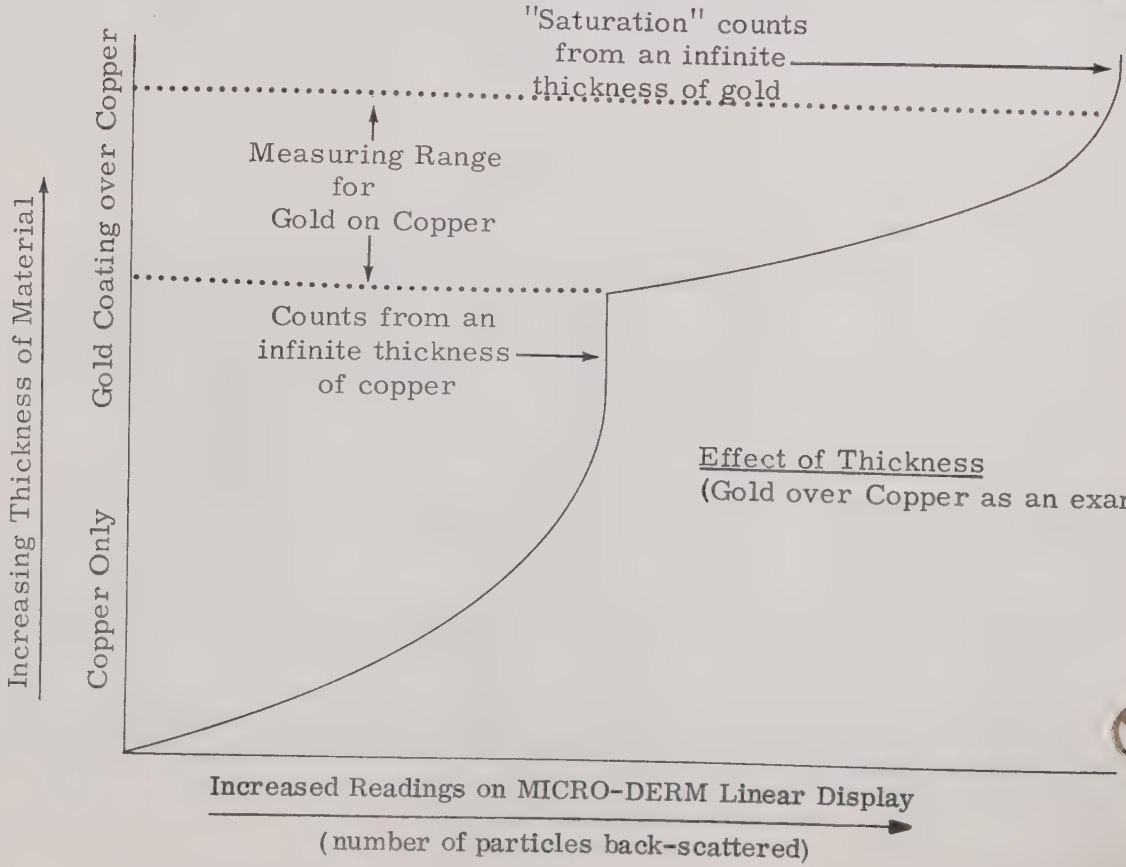
Additional Notes on MICRO-DERM Operating Principles

As indicated in paragraph 1-2, materials of higher atomic number reflect more Beta-rays than those of lower atomic number. In the case of a coating of one material on another, some of the Beta-rays will be backscattered by the coating material and some by the base. (Some rays are absorbed, but these cannot be counted.)



Backscattering of Beta-rays

In the particular case of gold plate over copper: As the gold coating thickness increases, more of the Beta-rays are reflected by the gold coating and less of the Beta-rays are reflected by the copper base. Therefore, as the thickness of the gold coating becomes heavier, the reading on the instrument will become higher, until the Beta-rays can no longer penetrate through the gold coating. At this point the coating appears infinite to the MICRO-DERM and additional thicknesses of gold coating do not produce higher readings.



Effect of Thickness
(Gold over Copper as an example)

Each isotope has a different penetrating ability. This depends on the energy of the Beta particles. (See table H-1 below.) For example, Promethium-147 (.22 Mev.) has a maximum measuring range of about 110 micro-inches **(2.7 microns)** in measuring gold, while Radium-D (1.17 Mev.) has a range of about 500 micro-inches **(12 microns)**. Typical maximum measuring ranges of sources in various materials are given on page 26.

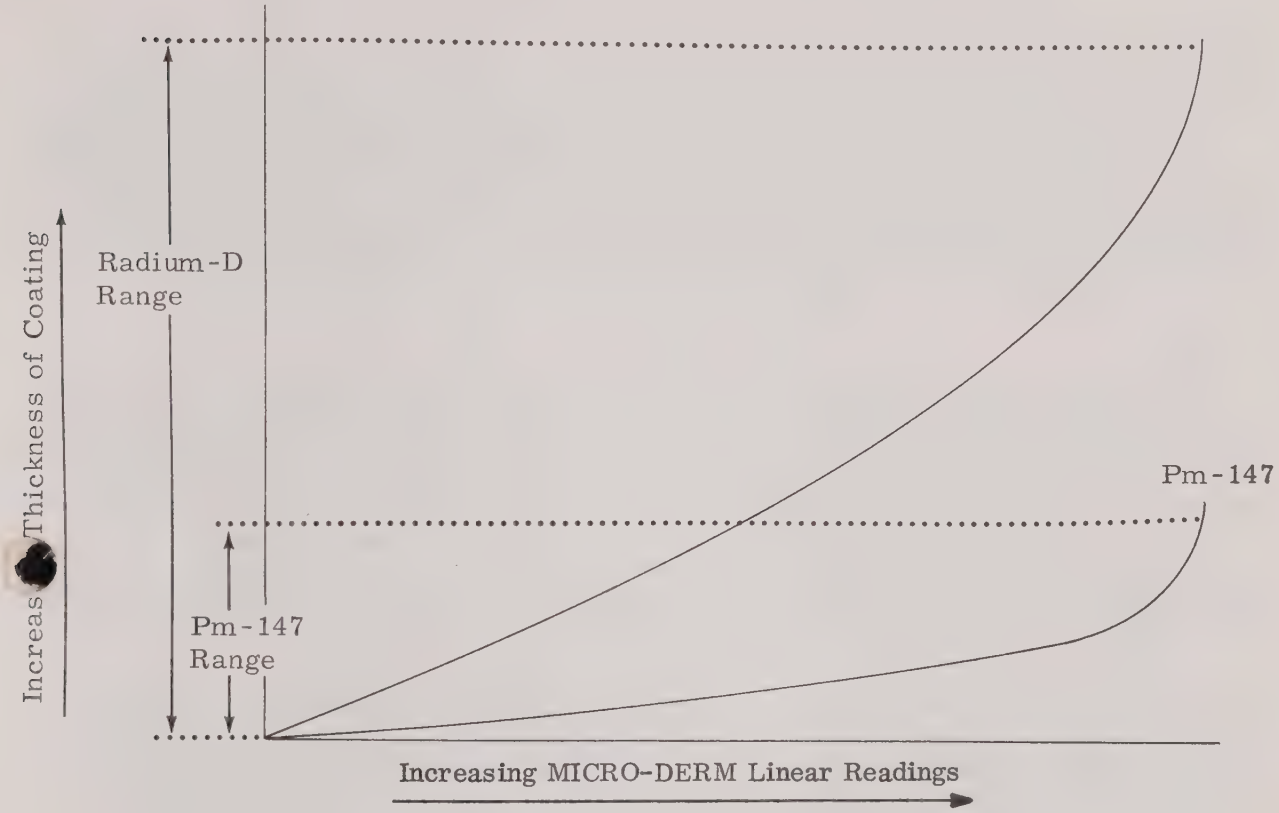


Table H-1. ISOTOPE SOURCE BETA ENERGIES

Isotope Source	Beta Energy (Mev.)
Carbon-14	0.155
Promethium-147	0.22
Thallium-204	0.76
Radium-D	1.17
Strontium-90	2.18

APPENDIX I

Correlation of MICRO-DERM With Microscope (Accuracy When Measuring Gold)

Purity:

The accuracy of the MICRO-DERM depends upon the accuracy of the Thickness Standard used to standardize the instrument. If the Thickness Standard provided does not correspond to the exact composition of the coating you are measuring, there will be a correction which must be made. For example, UPA Thickness Standards are plated from a 24K pure acid-gold plating bath which produces a pure gold. If your gold is less than 99%, a correction factor must be used when using UPA standards, or a standard should be prepared of the proper composition.

Density:

The beta backscatter method is sensitive only to coating weight per unit area and the thickness readings actually represent weight per unit area values converted to thickness values. All MICRO-DERM Thickness Standards are based on weight-per-unit-area values which are converted to thickness values using the theoretical density of the deposit. The primary standards are all made by a weight-gain procedure which means that a flat sample of substrate is carefully weighed, a coating is plated on a known area of this sample, then the sample is weighed after plating. The thickness of the coating is then calculated knowing the area plated, the weight gained by the plating, and the standard density of coating.

In the case of gold, in particular, there are some gold baths which produce less dense deposits, and a correction must then be made for this reason, or a Thickness Standard corresponding to this particular type of gold can be prepared and used with the same calibration range. Microscopic cross section will give somewhat higher values (mainly due to gold density variations). The difference in readings between the microscope and the MICRO-DERM (using UPA gold standards) can be as much as 15% to 25% and can sometimes be as high as 50%. Keep in mind that the MICRO-DERM, when using UPA weight-gain-standards, is actually measuring the weight-per-unit area of gold on the sample.

APPENDIX J

Determination of Measurability of a Particular Combination

To determine whether a particular combination of coating and base materials is measurable, use the following procedure:

If the names or atomic numbers of coating and base materials are known:

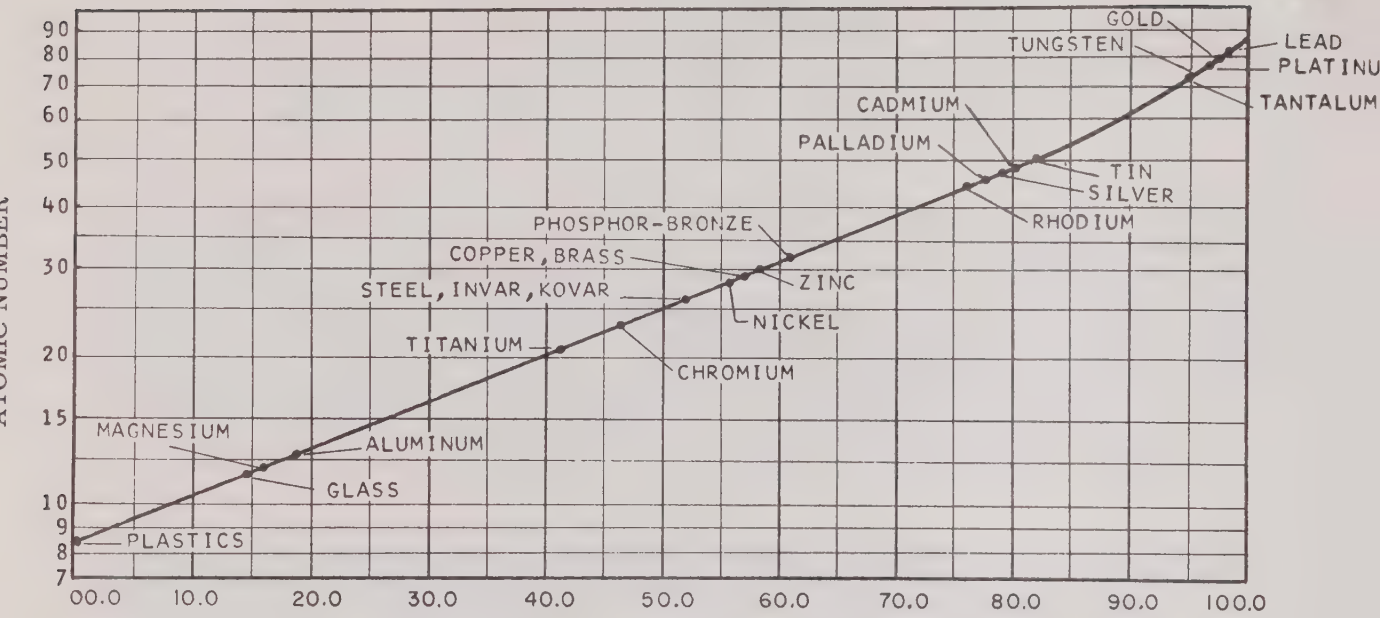
1. Refer to the chart below. If a black dot appears, the combination is measurable. (To find out which combinations have calibration ranges, refer to the list on pages 20 through 23 , as well as our latest literature.) If a black dot does not appear, the combination is not generally measurable.

2. Should your combination not appear, or the word "some" appears, measurability depends on the exact composition of the coating and base; refer to the graph on the next page.

REPRESENTATIVE COATING/BASE COMBINATIONS THAT CAN BE MEASURED

BASE MATERIALS \ COATING MATERIALS	CADMIUM	CHROMIUM	COPPER	GOLD	IRON	LEAD	NICKEL	PALLADIUM	PLATINUM	RHODIUM	SILVER	TANTALUM	TIN	ZINC	PLASTICS, PAINT, RUBBER, MOST NON-METALS	ANODIZING
ALUMINUM	●	●	●	●	●	●	●	●	●	●	●	●	●	●	SOME	SOME
BERYLLIUM COPPER	●	●		●		●		●	●	●	●	●	●		●	
BRASS	●	●		●		●		●	●	●	●	●	●		●	
COPPER	●	●		●	●	●		●	●	●	●	●	●		●	
IRON	●		●	●		●	●	●	●	●	●	●	●	●	●	
INVAR; KOVAR	●			●		●		●	●	●	●	●	●		●	
LEAD	●	●	●		●		●	●	●	●	●		●	●	●	
MAGNESIUM	●	●	●	●	●	●	●	●	●	●	●	●	●	●	SOME	SOME
NICKEL	●	●		●	●	●		●	●	●	●	●	●		●	
PHOSPHOR-BRONZE	●			●		●		●	●	●	●	●	●		●	
SILVER		●	●	●	●	●	●		●			●		●	●	
STEEL	●		●	●		●	●	●	●	●	●	●	●	●	●	
TIN		●	●	●	●	●	●		●			●		●	●	
TITANIUM	●		●	●		●	●	●	●	●	●	●	●	●	●	SOME
ZINC	●	●		●		●		●	●	●	●	●	●		●	
PLASTICS, GLASS, MOST NON-METALS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	SOME	

GRAPH FOR DETERMINATION OF MEASURABLE COMBINATIONS



RELATIVE LINEAR RANGE MICRO-DERM READINGS

How to use the Graph

The MICRO-DERM can measure the thickness of any combination where the coating and base materials are at least 5 units apart on the horizontal scale of this graph. (Note that this represents a difference of only one Atomic Number at the low end of the graph.)

Example: Gold on copper (which are 40 horizontal units apart) will be measured accurately by the MICRO-DERM. However, copper on nickel, which are only 2 horizontal units apart, cannot be measured accurately.

The atomic number of alloys can be found by "weighted-average" of the component elements. A list of some elements and their atomic numbers appears on the next page. For example, 60/40 Tin-Lead has an apparent atomic number (Z) of 63 ($Z = .60 \times Z_{Sn} + .40 \times Z_{Pb}$

$(Z = .60 \times 50 + .40 \times 82 = 30 + 33 = 63)$

NOTE

If the exact nature of coating and base material is not known and the samples of coating and base materials are available, see Appendix K, page A-14 for detailed experimental procedure to determine measurability.

LIST OF SOME ELEMENTS AND THEIR ATOMIC NUMBERS

Element	Atomic Number	Element	Atomic Number
Aluminum	13	Magnesium	12
Antimony	51	Manganese	25
Barium	56	Mercury	80
Beryllium	4	Molybdenum	42
Bismuth	83	Nickel	28
Boron	5	Nitrogen	7
Bromine	35	Osmium	76
Cadmium	48	Oxygen	8
Calcium	20	Palladium	46
Carbon	6	Phosphorus	15
Chlorine	17	Platinum	78
Chromium	24	Potassium	19
Cobalt	27	Rhodium	45
Copper	29	Selenium	34
Fluorine	9	Silicon	14
Gallium	31	Silver	47
Germanium	32	Sodium	11
Gold	79	Sulfur	16
Hydrogen	1	Tantalum	73
Indium	49	Tin	50
Iodine	53	Titanium	22
Iridium	77	Tungsten	74
Iron	26	Uranium	92
Lead	82	Vanadium	23
Lithium	3	Zinc	30
		Zirconium	40

APPENDIX K

Determination of Measurability of Unknown Materials

If the exact nature of coating and base material is not known, but samples of coating and base materials are available:

1. Use largest aperture size possible and install Promethium-147 Source (or Carbon-14 Source if available) in your probe system.

2. Set MODE switch to NORMAL position and RANGE switch to LINEAR position.

3. Rotate CAL control fully clockwise.

4. Set RATE switch to position 7 and TIMER control to 1/2 minute.

5. With no probe plugged in, push in RESET switch, release it, and wait for 1/2-minute interval to elapse.

6. After THICKNESS display lights up, hold RESET switch in and adjust ZERO control for a zero reading on display. Lock the ZERO control then release the RESET switch.

7. Set up the coating or base material, whichever one is suspected of having a higher atomic number, for measurement by the Probe System. If coating material is selected, use thickest piece available.

8. Plug in the probe, then push and release the RESET switch.

9. When THICKNESS display lights, note reading on display.

   (a) If the reading on the neon display exceeds 100.0 or over-range, hold the RESET switch in the depressed position and rotate the CAL control until the neon display reads exactly 100.0. Lock the CAL control, then release the RESET switch.

   (b) If the reading on the neon display is below 100.0, set the RATE switch to its next lower position, press and release the RESET switch, and repeat step 9. If you are already at the lowest rate (RATE 1), follow the procedure in Appendix L (page A-16).

10. Set up the material suspected of having the lower atomic number for measurement by the Probe System.

11. Press and release RESET switch.

12. When the THICKNESS display lights up, note the reading and use the following as the criteria of measurability:

(a) If the linear reading is less than 90.0, the combination is measurable.

(b) If the linear reading exceeds 100.0, the original assumption as to which material has a higher atomic number is wrong; the material suspected of being higher in atomic number is actually lower. Return to step 7, using the material of higher atomic number.

(c) If the linear reading falls between 90.0 and 100.0 and the sample of coating is known to be infinitely thick,* the combination is not measurable.

(d) If the linear reading is above 90.0 and the coating thickness is suspected of being less than infinite thickness, or very thin, the procedure in Appendix L (page A-16) may be used to determine if the combination is measurable. In this procedure, a test is made to determine the amount of spread between coating and base with the MICRO-DERM set up for maximum sensitivity.

* Refer to chart on page 26 for an indication of infinite thickness in terms of each isotope.

APPENDIX L

Setting the MICRO-DERM for Maximum Sensitivity

The following procedure may be used to determine if a coating-base combination is measurable when other tests are inconclusive (See Appendix K on page A-14). If a spread is not obtained at maximum sensitivity, then the combination is not measurable. Proceed as follows:

1. Place bare (uncoated) material on the aperture plate or specimen mask. Set RANGE switch to LINEAR position and RATE switch to position #1. The CAL control setting is unimportant at this time.

2. Set ZERO control so that "digi-dial" reading is approximately 100.

3. Set TIMER control to 1/8 minute and MODE switch to NORMAL.

4. Push and release RESET switch.

5. If the reading on the THICKNESS display does not rise above zero, use RATE switch position #1 for this test. If reading increases above zero, repeat test at next higher rate until a position is found where reading does not go above zero.

   To set up at maximum sensitivity:

   Use RATE switch position determined above and a time interval which is long enough to obtain good reproducibility (usually 1 minute or more).

CAUTIONS

1. It is only necessary to operate the MICRO-DERM at maximum sensitivity when measuring coating-base combinations that are relatively close in Atomic Number. However, when measuring other combinations such as gold on copper, this increased sensitivity may be undesirable, causing the readings of coated pieces to move off scale.

2. Do not make thickness measurements with CAL control set to digi-dial reading under 100. Thickness measurements made in this manner may be erroneous.

If testing a combination:

6. Leave uncoated material on aperture and rotate CAL control to its fully clockwise position. Set TIMER control 1 minute or more and RATE switch as indicated above for maximum sensitivity. Set MODE switch to proper position for combination you are measuring.

7. Push and release RESET switch and wait for unit to time out.

8. After THICKNESS display lights up, hold RESET switch in and adjust ZERO control for zero reading on neon display. Release RESET switch.

9. Place thickest available coated sample on aperture or specimen mask, press and release RESET switch and wait for unit to time out.

Criterion of Measurability:

(a) If the reading is above 60.0, the combination is measurable in the thickness range of the samples used.

(b) If the reading is between 60.0 and 30.0, and:

1. If you know that the coated piece used in the test is very thin, the combination is measurable.

2. If you know that the coating material is relatively thick, the combination is not measurable.

(c) If the reading is under 30.0, the combination is not measurable in the thickness range of the sample used.

APPENDIX M

General Procedure for Preparation of Thickness Standards

Materials Required:

In order to prepare an accurate final standard and calibration curve, you need a sample of the bare material (a piece with all coatings except the coating to be measured) and between 6 and 12 pieces with varying coating thicknesses on the same bare material. If possible, use actual production pieces, but if this is not feasible, obtain material of the exact nature of your production parts as far as heat treating, alloy composition, curvature, etc. is concerned.

Samples of the material must not necessarily be of the same curvature as production parts because certain characteristics of the MICRO-DERM may enable it to produce accurate thickness readings on curved production parts while standardization is accomplished on flat standards.

Procedure:

Put as many samples as you can in the same plating bath at the same time. Retain one bare sample and plate the others from 50-150% of normal plating time, removing and labeling one piece at a time as you go along. Remove two pieces at 100% of normal plating time. One of these two pieces will eventually be the set-up standard.

Set the RANGE switch to the LINEAR position and the RATE switch to its proper position for the particular coating-base combination and range. Since you are standardizing the MICRO-DERM, use a longer time interval for the TIMER control setting. Place the bare piece on the probe, then press and release the RESET button. When the THICKNESS display lights up, hold the RESET button in, adjust the ZERO control for a zero reading, then release the RESET button. Now place the most heavily coated piece on the probe, then press and release the RESET button. After the measurement time period elapses, hold the RESET button in and adjust the CAL control for a THICKNESS reading of 80.0 to 100.0. (The exact reading is not critical.)

Without touching the MICRO-DERM controls, place the intermediate pieces that have a coating thickness between the bare sample and the most heavily coated piece (that was already used) on the probe and note the readings obtained on the THICKNESS display. These readings will be plotted later on graph paper to form a calibration curve.

You must now determine the coating thickness of all the samples except for one of the two pieces plated at 100% of normal time. The second piece will be your thickness standard. Among the more popular ways of destructive testing are microscopic measurement, anodic solution method, chemical strip and weigh method, etc.

After you've determined the coating thickness which corresponds to each linear reading, you can plot these points to form a calibration curve from which other linear readings can be converted to coating thickness values. Proceed as follows:

1. Plot the MICRO-DERM linear reading range (00.0-100.0) on one axis of standard graph paper.

2. Plot the range of the coating thickness on the other axis.

3. Plot the points (from the pieces measured) on the graph. If a straight line can be drawn through these points within the range to be measured, the calibration curve can be used as is. However, if these points form a curve rather than a straight line, replot the curve on semi-log paper, repeating steps 1 through 3.

The thickness of the undestroyed piece (plated at 100% of normal plating time) is determined from the calibration curve since the instrument reading for the piece was previously taken. Mark this piece with its thickness. It is now your thickness standard and will be used to standardize the instrument, along with the same piece of bare material originally used.

APPENDIX N

Determination of "Calibration Number" for Non-Standard Combinations of Coating and Base Materials

1. Develop a calibration curve for the particular combination of coating and base materials, following the procedure given in Appendix M on page A-18. (Note that the RANGE switch is set to the LINEAR position and the CAL control is used to set the reading on the THICKNESS display for a particular thickness sample. The setting of the CHECKPOINT control has no effect on linear readings.)

2. Using the calibration curve developed for your coating-base combination, determine the thickness values that correspond to linear readings 90.0 and 45.0. Calculate the ratio of these two thickness values. This ratio will have a value somewhat greater than 2.0, possibly as high as 7.0.

NOTES

1. If your calibration curve is prepared on semi-log paper, only the straight portion of the curve should be used; measurements taken in the upper curved portion are invalid for the MD-3.

2. If your calibration curve is a straight line on standard graph paper, the thickness ratio is 2.0. In this case, no "calibration number" is required. Leave the RANGE switch in the LINEAR position and read off thickness values directly from the THICKNESS display.

3. From the curve labeled "Thickness Ratio Curve" on page A-19 determine the "Calibration Number" which corresponds to the thickness ratio calculated in step 2. That "Calibration Number" is the proper one for the thickness corresponding to linear reading 90 on the calibration curve.

4. From the "Graph for Determining Calibration Number of Thickness Standard" on page 25, find the "multiplied Thickness of Standard" that corresponds to the "Calibration Number" just located in step 3. Divide that value by the "90" thickness value to arrive at the "multiplier" for the system.

5. To determine the "Calibration Number" for any other particular sample of known thickness (having the same compositions of coating and base materials — and to be used with the same isotope source), multiply the coating thickness of the sample by the system's "multiplier" and with the resulting number, locate the desired "Calibration Number" on the "Graph for Determining Calibration Number" on page 25.

WARRANTY

The MICRO-DERM Non-Destructive Thickness Gauge has been designed and manufactured with the greatest of care. It has been given a heat-run for a minimum of 48 hours before shipment, and has been carefully adjusted and tested. The components are the finest available, and with proper care, this tester is capable of continuous service for many years.

This MICRO-DERM system is guaranteed against defective materials and workmanship for a period of 1 year from date of shipment, with the exception of the Geiger-Muller Tube which is guaranteed for 6 months from date of shipment.

This Warranty does not cover broken window of Geiger-Muller Tube, damage in transit, or damage caused by carelessness, misuse or neglect.

If it is necessary to return any part of the unit for repair, it should be carefully packed according to the instructions in the manual and shipped prepaid to the manufacturer. During the Warranty period, Unit Process Assemblies, Inc., will repair or replace defective items promptly at no charge for parts or labor. All shipping costs are to be paid by customer.

Unit Process Assemblies, Inc., does not assume any other Warranty, express or implied, and will not be responsible for any damage, injury or loss arising out of the use or application of this instrument.

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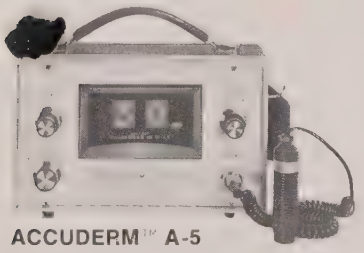
Eight great ways to measure coating thickness

MICRO-DERM® MD-3
The latest advance in beta backscatter thickness gauges for measurement of precious metal plating, photo resist and many other coatings; direct digital readings in millionths-inch, mils or microns; accurate, fast, easiest to use; solid state, IC construction. UPA



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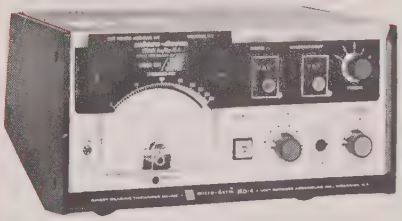

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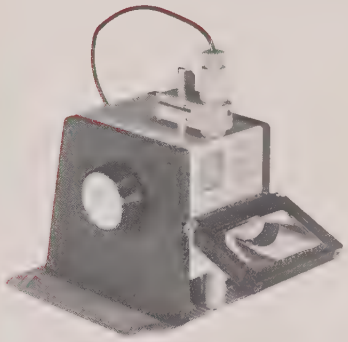

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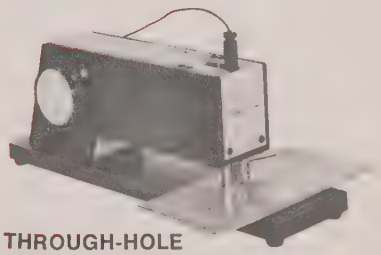

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